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What Is Ahead of the Farmer and the Engineer? - - - - - - - - - *L. F. Livingston*

Lower Cost Electric Wiring for Farm Applications - - - - - - - - - *M. H. Lloyd*

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Tests of Flat Steel Agitator Blades for Oil Sprays - - - - - - - - - - - - - - *K. R. Frost*

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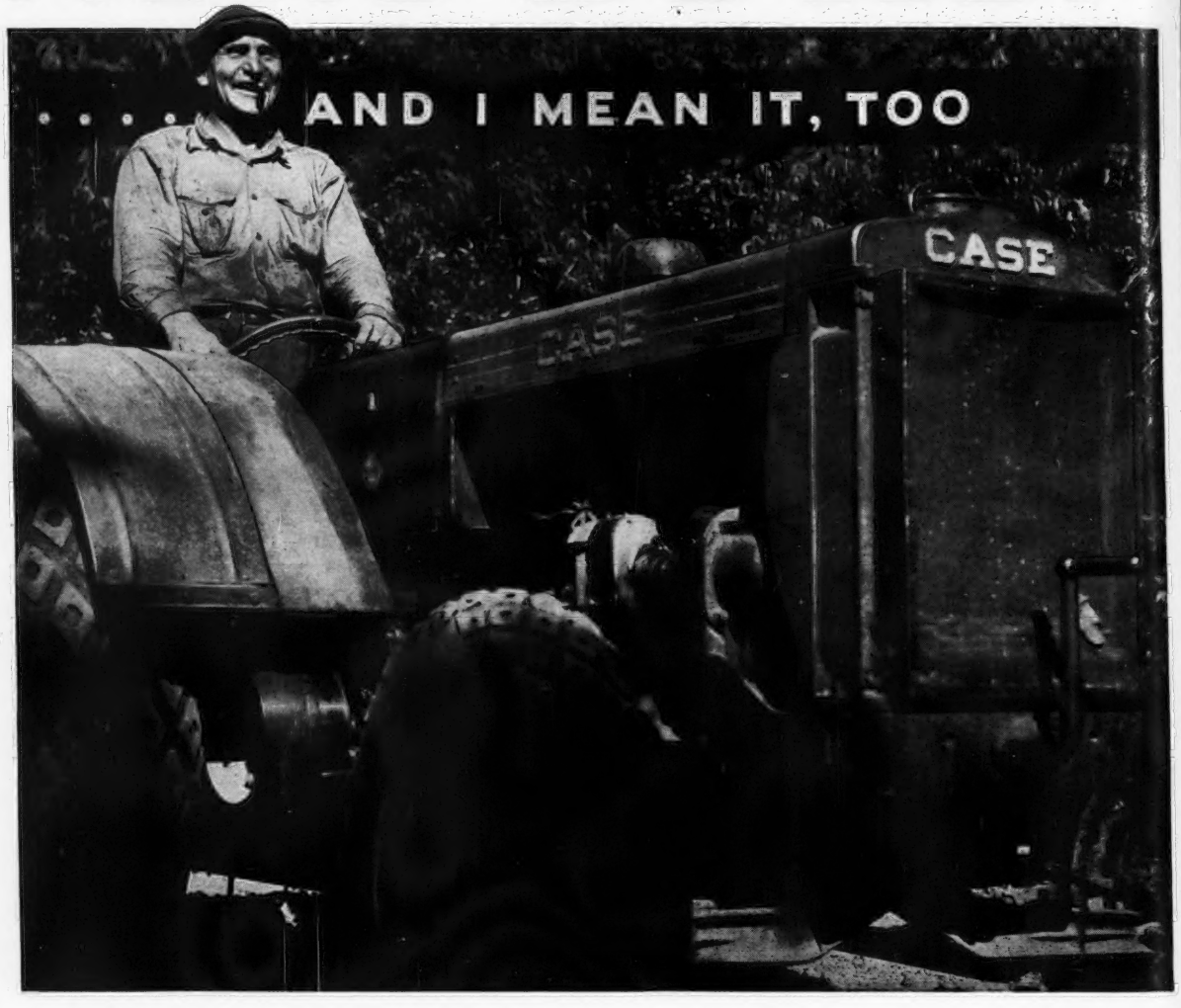
None Better



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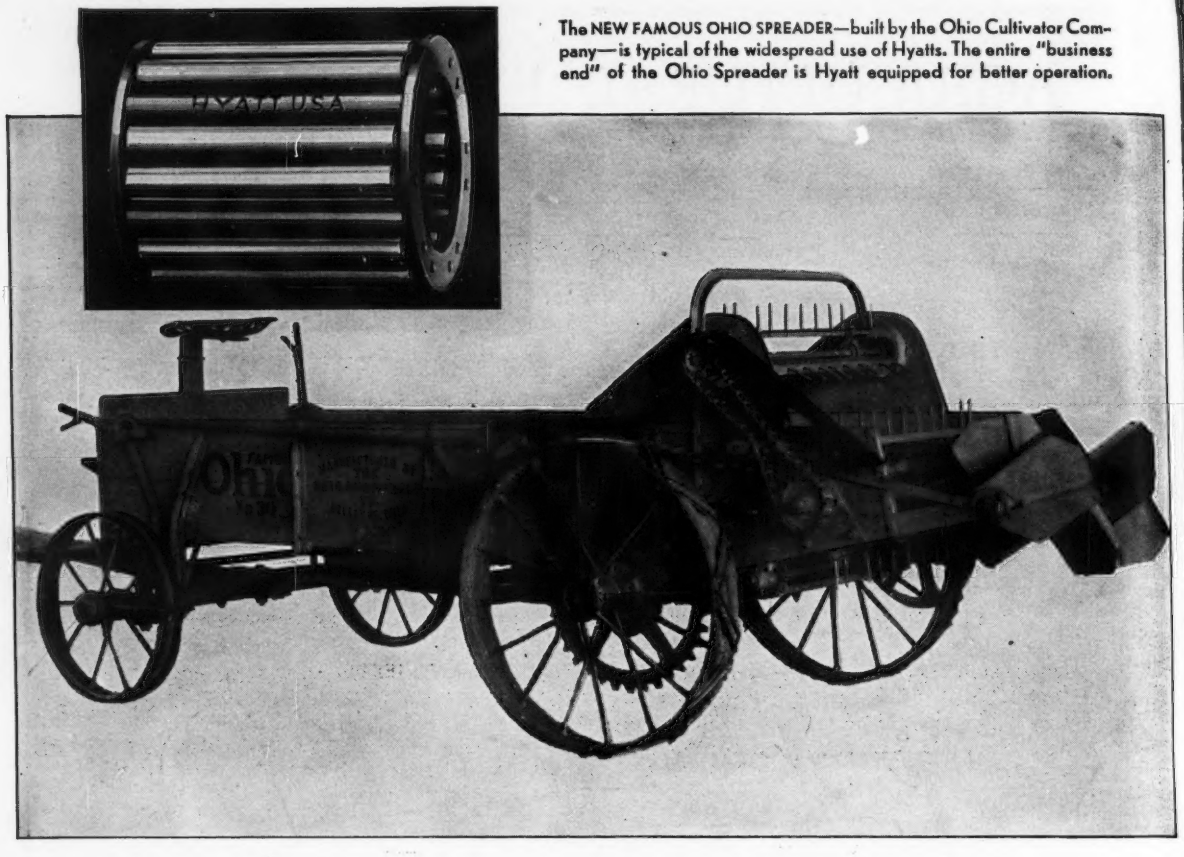

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AGRICULTURAL ENGINEERING

VOL 16, NO 11 EDITORIALS NOVEMBER 1935

The Challenge of Change

SELDOM does a single brief utterance so combine inspirational vision with critical analysis as is done in the North Atlantic Section address of ASAE President L. F. Livingston, appearing in these pages. Of the many themes deserving emphasis, that of eternal and ever-faster change seems most significant. The tradition of agriculture through the ages is that of slow motion, slow growth, slow turnover, slow evolution. Now we are faced with higher velocities in a host of ways, but above all in the rapidity of change.

Mr. Livingston sees fit to emphasize that governmental participation in agricultural adjustment embodies the principle of acceleration as well as that of deceleration. That principle, though conceived from the beginning and ably set forth by the responsible administrator of agricultural adjustment, has been too largely drowned out in the din of political embroilment. Yet acceleration is an older activity of government than restraint. How quickly we forget the slogan, "Food will win the war," even while we suffer in a crash intensified by the residual momentum from that acceleration.

Oxcarts and horse-paced tractors had little need of brakes. When change of pace and of method was slow in agriculture, it too had little need for brakes. It could coast to a stop, if need be, and even if it hit something there was no great shock. Radical as it seems to the static-minded, we were too late rather than too early in adopting a better braking system than economic impact. This may seem beyond the scope of the agricultural engineer, a trespass into the territory of economics and statecraft. But since agricultural engineering is a major factor in speeding up changes in agriculture, we must give a sober thought to its brakes as well as its motive power.

Bright as is the picture of an agriculture expanded by chemical and other industrial markets until the human stomach consumes but a minor fraction of its products, such change is fraught with hazard. Human hunger, our present main reliance, its relatively uniform. The industrial market will be subject to fluctuations in demand as those for steel, lumber, copper. An unplanned agriculture, scattered among six million competitive units, without effective means for immediate and adequate adjustment, will be crushed in the economic collision that marks a swing from maximum to minimum.

Our contact with the agricultural engineer indicates that he, as a composite, much prefers the spontaneous workings of economic force to any coercive control. He shares in shrinking from the aura with which "planned economy" has become surrounded. Yet he has seen at short range the wreckage that comes from unplanned economy. As his technical advances add to the rapidity of change and the variability of agriculture's markets, so is he duty bound to aid, at least, in meeting the social and economic problems which will be their inevitable and increasing consequence.

Harvest Machinery for Chemical Crops

MR. LIVINGSTON touches on the chemical and industrial promise in such strange crops as dahlias and Jerusalem artichokes. The latter, at least, is no newcomer to the realm of agricultural-industrial possibility. Its capacity for converting solar energy into carbohydrate must sooner or later be put to work, unless it is eclipsed by a still more efficient crop. At present its amazing capacity stands checkmated by lack of machinery for its proper harvest, cleaning, etc.

In contrast to the pride with which we view our work in the creation of combines, corn pickers, haying equipment, and other harvesting devices, we must confess glaring neglect of the root crops. Except for the potato and the sugar beet, we have not gone below the surface of the soil. Of course it has been true that the volume and concentration of commercial root-crop production has not demanded attack on the problems of mass production, harvesting, and preliminary processing.

Since the opportunities opened by organic chemistry depend utterly on the cheapness of the raw materials, we have a duty to the American farmer to keep in closest touch with the chemist, and to begin without delay such programs of research and development as will be necessary to mechanize crops or by-products that seem to show reasonable promise, in order that the commercialization of chemical discovery may not be unduly delayed. We suggest root-crop harvest as such a research project.

Tom Campbell and the Flings of Fortune

WHILE FULL TEXT is not available as this is written, advance notices indicate that "Fortune" magazine for this month contains an article in which Thomas D. Campbell is singled out as the symbol of all the sinister forces which together have created America's entire land conservation problem. To be sure, the text eventually points out that Mr. Campbell is but one among hundreds of thousands, perhaps millions of men, carrying on through several generations, whose combined activities created the conditions that invited wind and water erosion and their damage and destruction to millions of acres of land. It even concedes that all of these men were but creatures of circumstance, compelled to do as they did in an effort to get along under certain national policies and world pressures.

Being engineers rather than dramatists, we may not be enough impressed with the necessity for a personal villain. We may be too squeamish about that degree of demagogy which in selecting a villain simply strikes at the head which rises above the crowd. That is about the worst that can be

said of Tom Campbell. We could nominate several for the office of symbolic villain whose qualifications are more logical, and whose operations, while not so large, still should be sufficient to satisfy the gargantuan tastes of the "Fortune" reader.

True to journalistic practice and popular misunderstanding, this article seems to overemphasize wind erosion in comparison with water erosion. A speck of dust wafted into an urban eye looms larger than a cubic mile of silt added to the Mississippi delta. And while the Campbell holdings may not be immune to wind damage, at least they were not noticeable in the dust-storm dispatches, nor is that region recognized as a wind-erosion problem area. So, too, the topography on which Campbell actually operated is far from being conspicuously vulnerable to water erosion. If anything, our villain was shrewd enough to keep fairly well away from these hazards.

The article in question seems to imply that Campbell's use of tractors somehow aggravates his presumed offense—as if soil tilled by mechanical power is more susceptible to wind or wash than that turned by plodding beasts. Such an appeal to what has been termed the idiotic fringe, capitalizing the subtly cultivated antagonism to modern machinery in farming, can hardly be less than an affront to the type of clientele which "Fortune" is supposed to enjoy.

Campbell no doubt made mistakes, and he surely was victim in more than fair measure of the economic cataclysm which overtook us all. But he did make worthy contributions to the art of efficient agriculture, and in particular to our own field of agricultural engineering. His pioneer work with the windrow method of combining is alone sufficient to win for him abiding respect. In terms of national resources and their waste or conservation, the worst that can be said of him is that his methods were a little better than those of his lesser brethren.

Having thus challenged "Fortune" for casting as villain one who deserved no such distinction, let it be generously commended for a vivid presentation of the conservation problem, its enormity, and its significance not only to farm interests, but to the whole American people. All the more gratifying, it carries the message to an influential block of readers whose interest and information as to this subject is all too meager.

Agricultural Engineering Marches On

SOMEWHERE, before the dawn of civilization, a man and a woman sought a home for a little child. It may have been a cave, a crevice in the rocks, a tangle of jungle waste, or a hidden recess in the forest. It may have been furnished only with the skins of wild animals, or with matted leaves and branches; but it was a refuge. A refuge in which the child might grow—the one spot to lay claim of ownership, to be cherished and protected. It was man's first home.

To maintain that home and to provide a livelihood has been the problem of all ages and of all peoples. Today, as one drives through the country over ribbons of concrete roads, but little thought is given to the handiwork of the engineer who has transformed that wilderness refuge of yesterday into the farm and the farm home of today. The progress of civilization from darkness and danger and hardship and drudgery to light and safety and comforts and conveniences is largely the work of the engineer in applying his science to the age-old industry of agriculture.

The pages of future history are even now recording a most fascinating tale. Countless farm houses are being built or remodelled from carefully designed plans that correlate business and home life on the farm.

Washrooms, bathrooms, storerooms, laundry, clothes closets, heating, interior decorations, floor finishes, and insulation are all part of the new farm house. No longer will the exterior appearance resemble an afterthought; superfluous trimmings and decorations are being discarded, and in their place comes a reflection of the stability and dignity of rural life. The farm house is becoming a farm home, not merely a work shop or a place of protection from the elements, but a place to insure a greater degree of health, happiness, and comfort.

Barns and outbuildings are being designed to more definitely serve their purpose; waste space is being eliminated; economical construction details are being studied, and the relation of one building to another receives careful consideration. The farm arrangement eliminates small irregular-shaped fields and establishes a central business point from which all activities proceed with minimum time and effort.

Battles against the forces of nature are being fought and won. Waste areas are being reclaimed through drainage, explosives, and modern land-clearing machinery. Irrigation is erasing many of the ravages of drought. Crop rotation, gully control, terracing, and reforestation are halting the march of the soil to the sea.

Vast networks of electric power lines are spreading through the country bringing the conveniences to the farm home that have been the heritage of the city. The energy of some distant mountain stream is transmitted by slender copper wires and at the push of a switch is transferred into light, heat, and power. Light to dispel the darkness and radiate its cheer. Heat for the water, the ironer, or the electric range; heat that is safe and clean and almost magic in its automatic control. Power to pump the water, run the washing machine, operate the refrigerator; power, the willing slave of humanity, the agency of release of farm women from the bondage of drudgery.

New developments in farm machinery and power equipment are increasing the mightiness of man in his domination of the earth. The gas tractor from a huge, expensive, cumbersome, slow, and uncertain power unit has become a small, compact, economical, and highly efficient machine. No longer are its activities limited to tillage and belt operation. Its scope of usefulness has been broadened to include cultivation and harvesting and many other farm applications. Steadily the tractor is assuming the characteristics of automotive design. Low-pressure rubber tires are in use and may become standard equipment. Speeds are being increased to make a satisfactory transportation unit. Lights, brakes, and starters will add to the completeness so it will be equally effective in the field preparing the crop or on the highway marketing the finished product.

All types of farm machinery are being designed for complete tractor operation. The small combine harvester in one operation will be able to cut and thresh the grain. Labor-saving and time-saving equipment of all types will add their quota to an improved agriculture.

In all these movements, so essential to a prosperous and permanent agriculture, so necessary for the livelihood of millions, the trained agricultural engineer has his being and serves the purpose of his chosen profession.

J. H. GALLAGHER

Agricultural Engineer
Michigan State College

What Is Ahead for the Farmer and the Engineer?[1]

By L. F. Livingston[2]
President, American Society of Agricultural Engineers

THE primary interest of those of us here is the farm and its responsibility to the public at large. The farmer's job and the farmer's problem is essentially our job and our problem. It is altogether pertinent, therefore, to ask what is ahead for the farmer, because in attempting to answer that question we also answer what is in prospect for the agricultural engineer.

L. F. LIVINGSTON

Five years ago it might have been said that agriculture was at the crossroads—and all roads ahead looked bleak indeed. The golden era of farming seemed behind. As the gloom of general depression settled over the world, an even deeper pall darkened the agriculture landscape. The farmer was told that his ancient creed of plentiful yields spelled his ruin. The hungry cried for food, yet the farmer heard incredulously that his own salvation lay in producing less. Lean days and strange ways were upon the agriculturist, and apparently they had come to stay, paradoxically, because his cows supplied too much milk, because his acres yielded too abundantly and his hogs multiplied faster than the dollars needed to buy them. For the first time in American history the vast basic industry of agriculture came under governmental control. It was a situation without precedent, yet such was the emergency that something of the sort was mandatory to check the economic collapse of one-half our people.

Today, such has been the change in the national consciousness toward agriculture that even a casual review of developments presents a totally altered picture. We still have a farm problem, so-called, but factors that point to the permanent and satisfactory solution of that problem are now at work on a widely flung front. We still have crop control by governmental agency, and it may well be that some form of regulation will enter permanently into all farm production and use of land; but the future augurs not a control to curtail but a control to augment. The nature of this control may continue to be political to the extent that its source continues in the state, but, by and large, the most important agencies to the farmer in the not distant future are going to be those represented by the industrial purchasing agent, the research chemist, and the agricultural engineer. And it will be the task of the engineer, no small one either, to see that the farm acreage of the land produces handsomely. We are in the early dawn of a new golden era in agriculture. The first signs of that dawn are already streaking the agricultural sky.

Do not misunderstand me. I am not essaying the role of a prophet. My sole purpose is to call attention to an array of developments of very recent years—developments that are facts and not fancies—and, by putting those facts together, make the simple addition that two plus two equals four. We have been accustomed to pessimism in thinking of agriculture, but the situation of yesterday is no longer that of the present. Substantial and definitely constructive changes have been under way, even though they have passed unnoticed by us.

Industries rise and in their wake others decline and perish, but it is almost a law that the new is greater than the old.

There is in the making a new and a radically altered agricultural industry, the birth throes of which may be painful for the time, but which should not be mistaken for other than what they are. By every precedent this new industry should, in scope and importance, far exceed the old. It will be definitely allied with manufacturing, and the scientist and the engineer will be the chief lieutenants of both.

First, and by far the most significant of the recent changes bearing upon the future of American agriculture has been the rise in this country of an organic chemical industry. This development dating from the World War has been prodigious. In buildings and equipment for the training of chemists our schools and colleges alone have invested more than 300 million dollars. Chemical manufacturies have forged to the forefront of American business, and hundreds of laboratories have been established throughout industry dedicated to the improving of the old and the creation of the new.

Organic chemistry, as it is being practiced today, is a science of revolution. The chemist has learned how to create, not by accidental discovery or black magic but by cold scientific calculation based on experience and accumulated knowledge. His objective, let me make clear, is no longer imitation or duplication of natural products,—if it ever were that,—but it is the creation of materials non-existent in nature. For example, rayon is not an artificial silk, but a new fabric with properties of its own. A new elastic material resembling rubber (physically) is not a synthetic rubber, but a material of totally different chemical composition that in many ways is superior to rubber itself. But what is most to the point here, the chief raw materials of the organic chemist, the main tools of his trade so to speak, are organic things that grow from the soil. The organic chemical march toward change is over a road paved in large part by the products of American forests and farms.

The seeds of cotton were once a waste and a nuisance. Today, thanks to the organic chemist, the seeds from a billion-and-a-half-dollar cotton crop have a value of over $200,000,000 to the farmers. Billiard and golf balls, hair brushes and combs, electric insulators, photographic films, and the unseen binder that makes safety glass safe, all contribute their tithe to the southern cotton farmer. At the same time, more than a hundred commercial uses have been developed for corn, ranging from glycerines used in explosives to carbon dioxide used in making "dry" ice. More than one-tenth of the corn crop now has the factory as its

[1]An address before a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Ithaca, N. Y., October 7 to 9, 1935.

[2]Manager, agricultural extension section, E. I. du Pont de Nemours & Co. Mem. ASAE.

market. Wheat straw is being made into corrugated paper boxes; furfural produced from oat hulls is being sold in tank-car lots. The wall-board industry is based on the chemical conversion of farm by-products that only a decade ago were deemed next to worthless.

I might go on indefinitely for already the list of chemical conversions of farm products is long, although the industrial chemist is relatively a newcomer on the agricultural scene. The fact that he has such solid accomplishments so early to his credit is an augury of the future that we, as engineers, need most seriously to consider.

"The chemistry of the utilization of agricultural products and by-products or wastes is still in its infancy," Dr. C. M. A. Stine, one of our foremost industrial chemists, has said. Other observers, far more competent to detect the trend than I, see ahead a "factory stomach" that will consume far more of the products of our farms than all our hungry human stomachs.

A second development is taking place, which is an outgrowth of the one just mentioned, and only slightly less in its significance to the farmer. Big business, by which I mean our largest corporations, is becoming increasingly interested in the agricultural puzzle. Of course, the manufacturer has always been concerned about the farm as a market, but a new note is now evident. An unstable farm situation is a constant threat to business stability. Moreover, the manufacturer likewise has a production problem not less acute than that of the farmer. The factory capacity to produce is also beyond the existing market to consume, and one big reason is that the farmer has not the means to buy his share, due in large part to wastes and losses.

The annual waste in agriculture, or, to put it another way, the loss suffered by farmers yearly for which there is no return, mounts to almost unbelievable figures. More than 6,000 known species of insects are costing growers each year something like $2,000,000,000. Weeds cost $3,000,000,000. Plant diseases another billion and a half, making a total of $6,500,000,000. This is apart from the loss, equally staggering, that piles up yearly in the wastage of now unmarketable by-products.

GREATER RETURNS FOR THE GROWER AND LOWER PRICES TO THE CONSUMER—A PROBLEM FOR ENGINEERS

Almost, may it be said, that, for every dollar the farmer earns, he has another dollar taken from him by enemies against which he must wage ceaseless war. Any substantial reduction in that loss could mean two things—a greater return to the grower for his labor, and a lower price to the consumer. Lower prices on farm products, in turn, should lead to greater consumption both by the factory and by the human stomach. In the prosperous year of 1929, according to studies made for the Brookings Institution, an impartial scientific fact-finding agency, almost three-fourths of our non-farm population lacked the means to provide itself with an adequate diet at minimum cost, and ninety per cent of those not living on farms were unable to afford the food they would have liked, classed as a liberal diet. Twelve per cent of these families were merely subsisting on enough food to keep them alive.

By no means are we producing all the food we need. There is merely an overproduction of food that consumers can buy at existing price levels. At the same time price is a prohibiting barrier to the industrial use of many farm by-products. The quantity of cornstalks and straws annually produced in this country is several times that required to make all the paper and paper board now manufactured here, and there is no particular technological difficulty in making paper of various kinds from any of these materials. However, it is now cheaper to buy Canadian wood pulp and rags from China.

American industry wants to buy from the American farmer because it knows that the farmer, with money, will buy more from industry. But if farm products and by-products are to be consumed to the maximum, they must become cheaper. If they are to become cheaper, farming must become more efficient and be relieved of at least a portion of its tremendous losses. So, taking this long-range view, such great corporations as Standard Oil, Ford, du Pont, and others are today making the farmers' problems their own. And, again, perhaps the most important new factor in the situation is the industrial research chemist, backed by all the resources of almost unlimited capital, working with equipment superior to any before available, and with a half-lifetime of successful experience with similar problems in his own industry. The shock-troops of industry have been sent to the farm front. The effort has become that of a major national war, with even the man on the street discussing with more or less intelligence the "farm problem."

Each year the brain efficiency of the American farmer is being pushed up a notch to a higher level. You all have had a hand in that.

BEHOLD, AN ORGANIC CHEMICAL INDUSTRY WITH ONE FOOT IN INDUSTRY AND THE OTHER IN AGRICULTURE

These, then, are the factors of change. A new and all-embracing organic chemical industry has been established with one foot in industry and the other in agriculture. The research laboratories of big business have been joined with an unparalleled array of scientific talent from federal, state, college, semi-official, and private agencies. New pioneers have come to the land, and government, backed by the resources of the nation, is making the farm its Problem No. 1. If these factors do not spell a new agricultural industry within the next generation, then the past is no longer of any significance in charting the future.

This new agriculture may be something vastly different than the agriculture we have known. The crops of today may not be those of tomorrow. For example, sugar that is said to be far superior to cane and beet sugar can be produced from the common dahlia and the readily grown Jerusalem artichoke. We are only beginning to learn about proper diet; what is now a common weed may be tomorrow's wheat crop; initial phases of the processing of certain raw materials that go into manufacturing may be transferred to the farm and further mechanize it beyond present dreams.

But whatever the nature of the new farming, all the signs point conclusively to the augmented importance and influence of the agricultural engineer. More than ever he will be the emissary carrying change from factory, college, and laboratory to the managers and workers of the land. It will be his job to see that, as the factory demands, the farm produces. Large-scale use of farm products in manufacturing may even mean the concentration of certain crops in certain areas, not only best adapted to the growing of those crops, but to simplify their orderly assembly and transportation to the factory. Some of the most formidable problems involved in the industrial use of crops are engineering problems, purely and simply. No, the golden era of agriculture is not behind. Already the rooster of change is crowing-in another and a better day.

Lower Cost Wiring for the Farm[1]

By Morris H. Lloyd[2]

THE STIMULATED demand for electric service in rural areas is bringing about the extension of lines into more sparsely settled territory than that now served. In addition, minimum monthly charges or guarantees are being reduced by many utilities. It is essential, therefore, that farmers be encouraged to use more energy than has been customary heretofore on the average farm, if these new lines are going to earn sufficient revenue to be anywhere near self-supporting.

The sale of load-building appliances is generally facilitated by adequate wiring and frequently prevented by the lack thereof, for it often happens that a farmer will do without some piece of electrical equipment—a motor, for example—and continue to use a gasoline engine, if his wiring system would have to be revamped to permit the motor to function properly.

In general, the amount of money a farmer has to spend for wiring is limited, and it is desirable that he get as adequate a wiring job as possible from the standpoint of service entrance capacity and number of outlets, if he is to make the maximum use of electric energy.

The companies of the Niagara-Hudson System have been attacking the problem of lower cost wiring materials for some time and have initiated several trial projects, portions of which have since been adopted by the National Electrical Code as approved practices. These trial projects included the use of service-entrance cable, including unarmored types with uninsulated neutral conductor, bare ground wire, simplified grounding with a common ground wire and single-driven rod or pipe, simplified service-entrance switch with the meter ahead of the fuses, and the use of non-metallic sheathed cable in all farm buildings. A service-entrance capacity formula has also been put in use through a trial project which is still in effect, and which was secured by the Central Hudson Gas and Electric Corporation, and these companies are cooperating through the Empire State Gas and Electric Association in the establishment of a trial project covering the use of non-metallic sheathed cable with an uninsulated neutral wire for interior wiring, together with a suitable line of boxless, non-metallic fittings; also the use of an unfused main switch. In addition, and not covered by the Code, pole metering is used on those farms where it will reduce wiring costs.

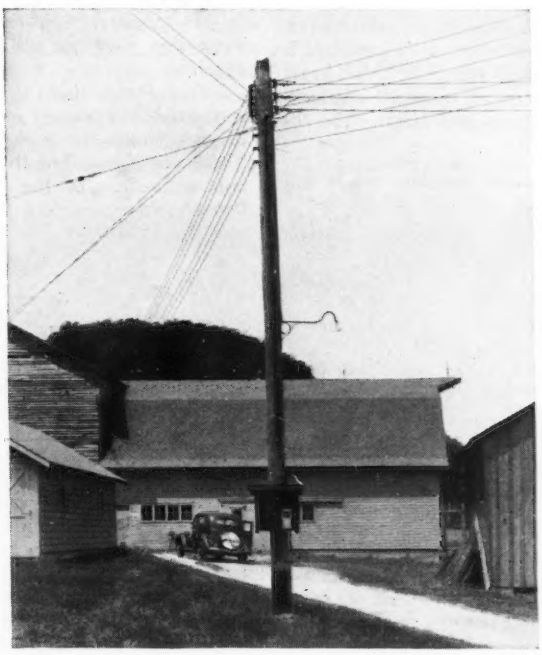
[1]Paper presented at a meeting of the North Atlantic Section of the American Society of Agricultural Engineers, at Ithaca, N. Y., October 7 to 9, 1935.

[2]Rural service engineer, Buffalo Niagara and Eastern Power Corporation. Assoc. Mem. ASAE.

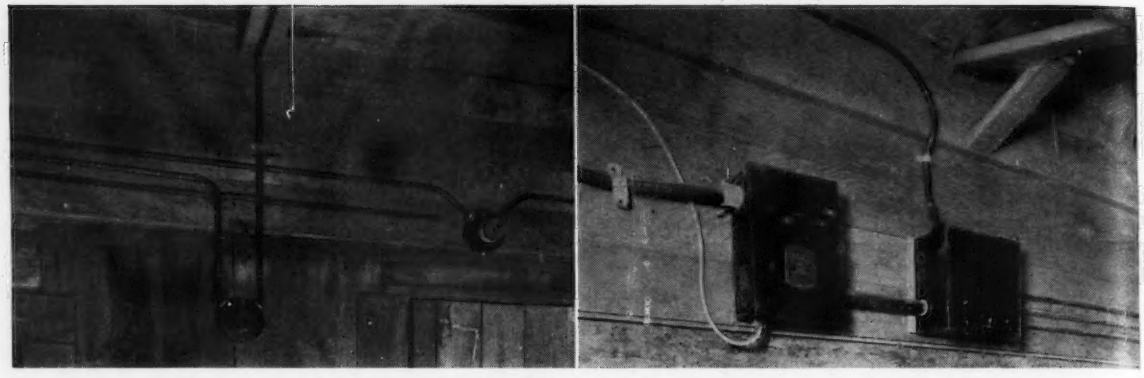
SERVICE ENTRANCE CABLE. The high cost of installing electric ranges brought about a study of means of reducing these costs item by item, and the use of service-entrance cable appeared to be a desirable starting point. The first service-entrance cable consisted of three stranded, rubber-covered conductors of B & S Gauge Nos. 6, 4, or 2, held together under an interlocking armor, the spaces between the wires being filled with a waterproof compound, and the entire assembly covered with a weatherproof braid. The nature of the compound made working with this cable very disagreeable, and it was soon discontinued. Following this came a cable with the same construction but without the compound, and then a cable with an uninsulated neutral made up of smaller strands than the insulated wires. In some cases, the neutral was reduced in size, that is, a cable of two No. 6 and one No. 8, or a cable of three No. 6 wires was available. This line of cables had a non-interlocking armor wrapped directly over the neutral conductor which surrounded the two insulated wires. This type of cable has now given way to one similarly constructed but without the armor, and which looks very much like ordinary non-metallic sheathed cable, but is not.

GROUND WIRE. Coincidental with the introduction of service-entrance cable was that of uninsulated ground wire in two types: (1) bare, armored No. 8, and (2) bare, stranded No. 6 unarmored. The wire is stapled directly to the surface wired over. It need not be protected, except where exposed to severe mechanical injury. It is used for both neutral and equipment ground, as it is connected to the neutral block in the entrance switch and run from there to the equipment grounding stud. This eliminates the practice of running a No. 8 insulated wire inside a ½-inch conduit used for the equipment ground. Since an equipment ground is required at each farm building in any case, no additional expense is involved in grounding the neutral as well, since it is only necessary to bond neutral and equipment together as above described. This makes it possible to use a single-driven rod or pipe for neutral and equipment grounds at service entrance, since the Code permits a single grounding electrode, provided that the neutral is grounded at three or more points. The grounding of neutral in each building is recommended to secure lowest possible combined resistance.

ENTRANCE SWITCHES. At the time that service-entrance cable and simplified grounding were introduced, the companies in the Niagara-Hudson System adopted a set



A pole meter with main switch. This installation is on a farm in Cattaraugus County, New York



(Left) Close-up view of non-metallic sheathed cable in a barn. (Right) Service entrance switch in a barn, showing entrance cable at left, bare No. 8 armored ground wire, and distribution cutout box, with non-metallic sheathed cable circuits. No meter is shown as this installation includes pole meter

of standard, uniform service entrance and meterboard layouts for all types of single and three-phase service, whereas before this time there were about as many different layouts as there were companies. As far as single-phase residence service is concerned, this entailed a minimum specification of three No. 6 wires and a group of 60-ampere simple safety switches as produced by the several manufacturers. The meter is ahead of the switch, and all meter test facilities are now provided by the company, whereas formerly many of the companies required a switch having meter test facilities and accessible main fuses. On all company range installations a combination switch is required having a main fuse block, a range fuse block, and four branch circuit-fuse positions. This is widely used on other installations and is suitable for a three-wire, 60-ampere barn service, as it would provide for one heavy-duty, 50 or 60-ampere branch circuit.

SERVICE-ENTRANCE CAPACITY FORMULA. The service-entrance capacity formula previously mentioned is known as Trial Project No. 4 and applies in Niagara-Hudson territory covered by the Syracuse division of the New York Fire Insurance Rating Organization, which organization has charge of all wiring inspection outside of the metropolitan area and the city of Buffalo and suburbs. It is a method by which the size of entrance wires and switch or circuit breaker is determined by formula instead of the total connected load. Its use is limited to residences and farms. The formula is as follows:

> "For all lighting and all appliances each less than 1650 watts, ½ ampere per outlet (at 115 volts), but not less than 5 amperes (at 115 volts) for any branch circuit.
>
> "For appliances of 1650 watts, or larger, 1—80%; 2—75%; 3—65%; 4—50% of full name-plate rating.
>
> "Aside from figuring the service according to the above specified method, the National Electrical Code rules apply.
>
> "Switch outlets will not be counted. Each duplex convenience outlet will be counted as one outlet.
>
> "Under the terms of this proposal, no service will be installed with line conductors smaller than 3 No. 6. No service breaker smaller than 50 ampere, and no main switch and fuses smaller than 60 ampere will be used."

The formula recognizes the diversity existing in residence loads. Hundreds of careful tests have confirmed operating department experience that the electrical demand placed on entrance wires and main switch is only a fraction of the total connected load in a residence. The lights are never all in use at the same time, range units are not all operated at high heat simultaneously, and diversity exists between appliances and lights. As a result, a service capable of carrying 12 kilowatts continuously will handle a connected residence load of 20 kilowatts or more with perfect satisfaction and safety.

This formula will be found especially useful in case a water heater or other heavy-duty appliance is to be added in a residence where a range service is already installed, or where the range is to be replaced with one of higher wattage rating. In such case it will seldom be necessary to replace the service. The formula also has application for farm loads where incubators, dairy utensil sterilizers, and other high-wattage equipment is in use.

Let us assume a farm with house and barn to be wired for the following loads:

House:	Range	8,500 watts
	Water heater	2,000 watts
	Lighting	2,000 watts
Barn:	Dairy scalder	2,000 watts
	Lighting	1,500 watts
	Total	16,000 watts

The barn is located 300 feet to the rear of the house; service and meter are in the house.

If the usual basis of connected load is used in determining the size of service-entrance conductors, we find that 16,000 watts represent 69.5 amperes at 230 volts and that three No. 4 wires and a 100-ampere main switch are required.

Trial Project No. 4, however, recognizes that the full connected load is never in use at one time, but that diversity exists between the various lighting and appliance loads. The actual demand of the residence or farm installation is only a fraction of the connected load. Applying Trial Project No. 4 we find three appliances each over 1,650 watts, as follows:

Range	8,500 watts
Water heater	2,000 watts
Scalder	2,000 watts
Total	12,500 watts

Multiplying by the factor of 65 per cent, results in a wattage of 8,125 to be wired for in the service, equivalent to 35 amperes at 230 volts. Assuming that the 3,500 watts of lighting in the house and barn are wired on five circuits, we require 5 amperes times 5 circuits, or 25 amperes in the service at 115 volts; 12.5 amperes at 230 volts. The total capacity to be wired for then becomes 35 amperes plus 12.5 amperes, or 47.5 amperes, for which three No. 6 conductors and a 60-ampere switch are sufficient.

Trial Project No. 4 can be used not only for figuring the main service entrance, but also for service exits and entrances beyond the meter feeding the various outbuildings of the farm. Where any amount of heating load is in use

which has a reasonable diversity factor, a saving in wiring costs is thereby effected.

POLE METERING. The matter of pole metering is one outside of the jurisdiction of the National Electrical Code, as it is outside of any insured building and the feeders from the meter pole enter the buildings in an approved manner. The presence of any combination of the following three conditions may indicate the desirability of this form of meter installation:

1 Buildings over a scattered area are wired
2 Appreciable load is installed or contemplated in each of two or more buildings
3 House and barns are on opposite sides of the road along which the company's distribution line extends.

The company furnishes for installation by the customer's contractor a suitable weatherproof cabinet to house the meter and its test block. From the cabinet the contractor installs a 1½-inch rigid conduit up the pole terminating in a four-wire weatherhead. Four No. 2 rubber-covered conductors extend from the meter box to the pole top, two for line wires and two for load. The neutral is not carried down the pole but is cut through solid at the pole top, and the equipment only is grounded at the pole.

For an example, let us turn to the installation used in the explanation of Trial Project No. 4 with meter in the house. We have already found that the total load of 16,000 watts can be carried on three No. 6 wires and a 60-ampere main switch. We can determine the size of conductors to the barn in several ways. If figured in accordance with the National Electrical Code, the total load of 3,500 watts requiring 15 amperes at 230 volts could be carried on three No. 14 conductors. While this would give a voltage drop of 25 volts, and hence be impractical, it is outside construction, and good practice would require a minimum of three No. 8 conductors for mechanical strength. On checking we find that, if 15 amperes are carried 300 feet with No. 8 conductors, a loss of 6 volts will occur, which would cause unsatisfactory operation of the lights and of the dairy scalder.

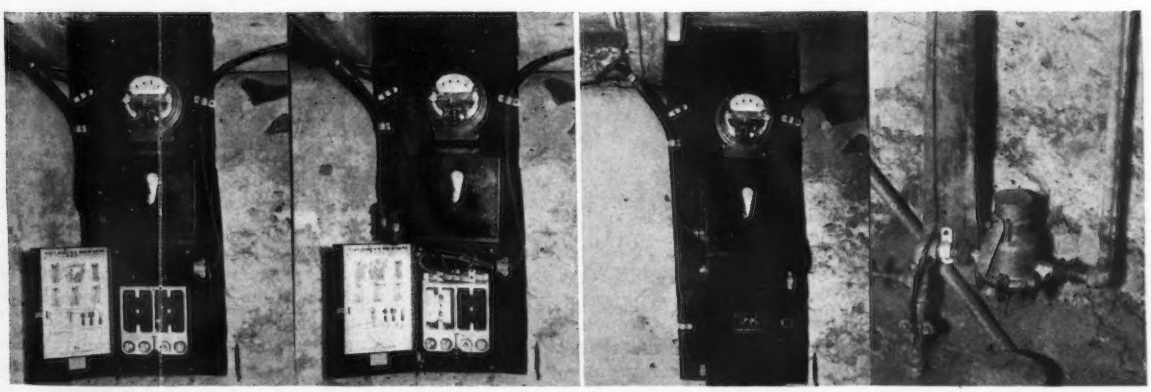
Hence, if we design the circuit from the voltage-drop standpoint, allowing a loss of 1 per cent, a distance of 300 feet, and a load of 15 amperes, we find that three No. 4 conductors are required. Two No. 4 "hot" wires will satisfy voltage-drop requirements, and Code requirements will be satisfied with No. 8 wire, which size could be used in the neutral and in the exit from house and entrance to barn.

Now let us assume that a year or two after this installation has been completed the farmer decides to add a 7½-horsepower, single-phase motor to his barn equipment. This motor has a full-load running current of 34 amperes, and, in accordance with the Code, the circuit carrying it must have a current-carrying capacity of 125 per cent of full load current, or 42.5 amperes. If the meter remains in the house and this amount is added to the original load of 47.5 amperes, for which the service entrance was designed, it is found that the three No. 6 wires and the 60-ampere switch are too small and will have to be replaced by three No. 2 wires and a 100-ampere switch to carry the new load of 90 amperes. The three No. 8 wires necessary as an exit from the house and as an entrance to the barn, together with the two No. 4 wires and one No. 8 between house and barn, will have to be changed to carry the new total load of 42.5 plus 15 amperes, or 57.5 amperes. In this case the Code would require three No. 4 wires in house exit and barn entrance, as well as overhead between the two locations, while if we hold to the 1 per cent voltage drop, the two hot conductors between house and barn should be increased to No. 3/0. A 100-ampere entrance switch at the barn would be necessary as well. We can hardly assume less than the total load in use at one time, since it is entirely possible for the scalder and lights to be in use at milking time, along with the 7½-hp motor driving a feed grinder.

Suppose, however, that we run the new service direct to the barn and feed back to the house. The connected load in the house is 12,500 watts. Code requirements would call for No. 4 wire as the load is 54 amperes. On the basis of 1 per cent voltage drop for this load, No. 3/0 wire is necessary. Trial Project No. 4 would reduce the load to a total of 41.5 amperes at 230 volts, for which No. 6 wire could be used. Code requirements under the trial project could be satisfied, therefore, by installing an exit on the barn of three No. 6 wires, and by using the former house entrance. The existing house exit of three No. 8 wires would be removed from the house. From a study of actual operating conditions, we know that the demand on the range will seldom exceed 4,000 watts. The water heater and a portion of the lights may be in use at the same time. Hence the total demand may be:

Range	4,000 watts
Water heater	2,000 watts
Lights	300 watts
Total	6,300 watts, or 27 amperes at 230 volts

No. 1 conductors are required to carry the load a distance



(Left) Combination service switch and cutout box as used on range installations: Range circuit open and cover removed (right view); switch in normal operating position (left view). Note service-entrance cable entering left side of test box, range feeder leaving right side of switch, also bare No. 6 stranded ground wire and one circuit of uninsulated neutral non-metallic sheathed cable near service entrance cable. (Right) At the right is a No. 6 bare stranded ground wire and clamp on water entrance. At the left is a combination switch, meter test cabinet, and meter. Note 3-wire, No. 6 bare neutral service drop cable entering at upper left; No. 6 bare stranded ground wire and 2 No. 14 bare neutral non-metallic sheathed cable leaving left of cabinet, range circuit in similar cable, 2 No. 6 and 1 No. 8 bare, at right

of 300 feet with a 1 per cent drop. Thus two No. 1 conductors should be installed for voltage-drop requirements and one No. 6 wire for Code requirements in the neutral between barn and house.

All of this serves to illustrate the value under certain circumstances of considering a pole meter. In such a case, the service-entrance capacity formula applies separately to each building entered directly from the meter pole. In this case for the residence we would have two heating appliances each rated in excess of 1,650 watts, to which the factor of 75 per cent would apply. The total load to be wired for works out to be 41.5 amperes, for which three No. 6 wires and a 60-ampere switch will be adequate.

For the initial installation in the barn we will have a load as follows:

Scalder—2000 watts	8.7 amp at 230 v
Lighting—1500 watts, 2 circuits of 5 amp at 115 v	5.0 amp at 230 v
Total	13.7 amp at 230 v

As before, this load could be handled with three No. 14 conductors as far as safe carrying capacity is concerned. Good practice requires No. 8 wire, however, with a 30-ampere switch. Assuming that the distance from the meter pole to barn is 250 feet, and keeping within 1 per cent voltage drop, No. 4 wires should be used. Thus two No. 4 and one Code size No. 8 neutral could be installed.

With the addition of the 7½-hp motor, the pole meter and house service would be undisturbed. At the barn we would have a new load of 13.7 plus 42.5 amperes, or 56.2 amperes. The three No. 8 wires and 30-ampere switch on the entrance must be changed to three No. 4 wires and a 100-ampere switch.

From meter pole to barn the code requirement would be three No. 4 wires, but the 1 per cent voltage-drop requirement necessitates two hot wires of No. 2/0 size. As No. 2/0 is exceptionally large, some saving in copper could be effected by using two No. 1 wires and a No. 4 neutral, giving a drop in voltage of 1.35 per cent which would probably be satisfactory.

For the total load including motor under the three different conditions of meter location, we have:

METER IN HOUSE
Main service entrance, 3 No. 2 wires
Main service switch, 100 amperes
Exit from house, 3 No. 4 wires
Overhead to barn, 2 No. 3/0; 1 No. 4
Entrance to barn, 3 No. 4 wires
Barn service switch, 100 amperes

METER IN BARN
Main service-entrance, 3 No. 2 wires
Main service switch, 100 amperes
Exit from barn, 3 No. 6 wires
Overhead to house, 2 No. 1; 1 No. 6
Entrance to house, 3 No. 6 wires
House service switch, 60 amperes

METER ON POLE
House service entrance, 3 No. 6 wires
House service switch, 60 amperes
Overhead from pole to house, 3 No. 6 wires
Barn service entrance, 3 No. 4 wires
Barn service switch, 100 amperes
Overhead from pole to barn, 2 No. 1; 1 No. 4 wire

NON-METALLIC SHEATHED CABLE. Non-metallic sheathed cable has been on the market for a number of years, under several trade names, among which are Rome X, Braid-X, Loom Wire. Under the 1931 Code, it could not be used in places not continuously dry. This was interpreted as preventing its use in farm outbuildings and basements. The custom developed for inspection departments to require that electrical contractors install rigid conduit or lead-covered armored cable in those farm buildings where moisture or ammonia fumes were present and in farm house basements with earth floors, the mistaken thought being that these methods provided maximum protection against corrosion.

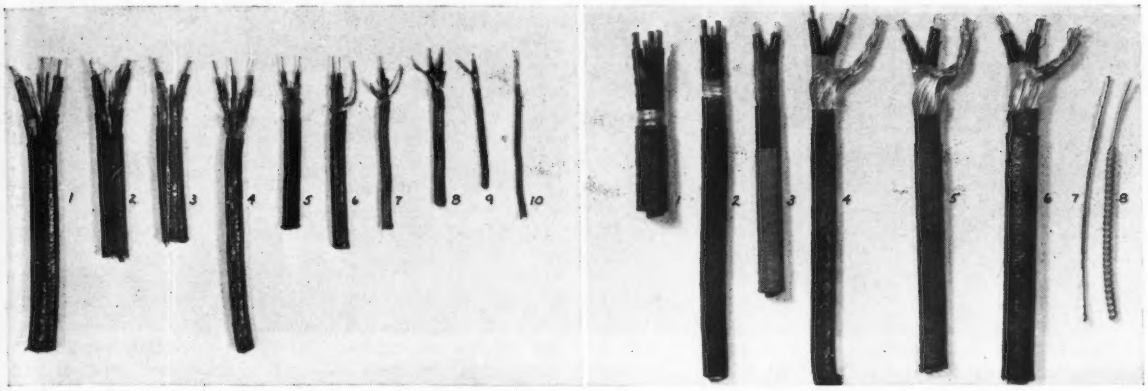
A trial project, started in 1932, permitted the use of non-metallic sheathed cable in residences and farm buildings on any interior installation not set in masonry, concrete or fill, nor buried in plaster. This provision was incorporated into the 1933 Code. Experience has shown that this material provides a more durable and a safer wiring method in dairy barns, poultry houses, and other farm locations than does conduit or lead-covered armored cable as it cannot rust nor corrode. In addition, the sheath is non-conducting, hence no possibility exists of voltages fatal to cattle being built up, as can happen when a "hot" conductor grounds to conduit or to the sheath of armored cable. Its use reduces wiring costs considerably. No special bending or threading tools are necessary; a pair of pliers and a knife are the only tools needed to cut and strip the covering. It can be installed in about half the time of a similar conduit job and at less than one-third the material cost of conduit or BXL, and at about the same cost as ordinary BX cable.

Quite a little opposition was evident on the part of electrical contractors when non-metallic sheathed cable was made applicable to such farm work as noted above, on the ground that this was a step backward from an all-metal installation and that it would cut down their profit. Experience has demonstrated, however, that they can now wire barns within a price the farmer can pay, whereas many barns were not wired at all when conduit work was required; or that if a farmer has a definite amount of money to spend for a wiring installation, he can be sold a more complete job with more outlets when the work is done in non-metallic sheathed cable. We have been informed by the inspection department of the Hydro-Electric Power Commission of Ontario that they will no longer approve new farm wiring installations not installed in non-metallic sheathed cable. It has found favor in several states where the types of soil makes it difficult to establish good, low-resistance grounds.

NON-METALLIC SHEATHED CABLE WITH UNINSULATED NEUTRAL. At the time that the service-entrance cable with an uninsulated neutral conductor came into use in 1931, permission was also given to use an uninsulated or bare neutral in the circuit feeding an electric range. The various non-metallic sheathed cables are now available with two insulated No. 6 wires and an uninsulated No. 8 wire; also with two insulated No. 8's and an uninsulated No. 10. The 1935 Code, section 517, will approve a bare neutral in the range circuit if service-entrance cable is used.

If an uninsulated or bare neutral is approved for a range circuit, it would seem logical that it would be equally safe and satisfactory for other purposes. Accordingly, a number of the wire and cable manufacturers have made plans for the production of such cable in a full line of sizes from two-wire No. 14 up. The General Cable Company and the U. S. Rubber Products Company have actually brought the two-wire and three-wire No. 14 cable on to the market at a price tentatively set at fifteen per cent below standard cable.

At present, of course, this material is not approved by the Underwriters' Laboratories, but since it offers possibilities for further savings in farm wiring costs, the Empire State Gas and Electric Association has made application to the National Board of Fire Underwriters for a trial project



(Left) Samples of non-metallic sheathed cable. (1) 2 No. 6 insulated, 1 No. 8 uninsulated wire; (2) 2 No. 8 insulated, 1 No. 10 uninsulated wire; (3) 2 No. 8 insulated wires; (4) 3 No. 14 insulated wires; (5) 2 No. 14 insulated wires; (6) 2 No. 14 insulated, 1 No. 14 uninsulated wire (General Cable Co.); (7) 1 No. 14 insulated, 1 No. 14 uninsulated wire (General Cable Co.); (8) 2 No. 14 insulated, 1 No. 14 uninsulated wire (U. S. Rubber Products Co.); (9) 1 No. 14 insulated, 1 No. 14 uninsulated wire (U. S. Rubber Products Co.); (10) 1 No. 10 rubber-covered wire for size comparison with Nos. 6, 7, 8, and 9. (Right) Samples of service-entrance cables and ground wires. (1) 3 No. 4 insulated wires, interlocking armor; (2) 2 No. 6 insulated, 1 No. 8 uninsulated, non-interlocking armor; (3) 2 No. 6 insulated, 1 No. 8 uninsulated, no armor; (4) 2 No. 6 insulated, 1 No. 6 uninsulated, no armor; (5) 2 No. 4 insulated, 1 No. 4 uninsulated, no armor; (6) 2 No. 2 insulated, 1 No. 2 uninsulated, no armor; (7) No. 6 bare stranded ground wire; (8) No. 8 bare armored ground wire

to permit the use of this type of cable with a "Trial Installation Label" in 5,000 farm wiring installations in the state of New York.

Should this type of cable be approved, it is very likely that it will become much cheaper than fifteen per cent under the present approved type of non-metallic sheathed cable, perhaps twenty-five to forty per cent.

Along with the application for this trial project was included a request for permission to use a line of suitable non-metallic fittings. While these are not yet on the market, two manufacturers have started to develop them.

If we are to have non-metallic cable for a wiring system, it seems unnecessary to use metallic outlet boxes. A line of non-metallic fittings would, therefore, be a logical development and should offer another opportunity to cut costs.

UNFUSED MAIN SWITCH. As previously mentioned, application has been made for a trial project on an unfused main switch. The reasons for this are

1. The lighting branch circuits are fused, as is also the range circuit and any other circuits
2. If main is also fused, and range and some other circuits are fairly well loaded, it is an even chance as to whether range or main fuse will blow when an overload occurs on the range circuit
3. Some possibility exists of saving in cost of the switch.

Based on these reasons, it is believed that the main switch itself might better be left unfused, to function as a disconnect only, while circuit protection is left to the circuit fuses. Such a switch is not yet on the market, however.

COST COMPARISONS. Some cost comparisons will be of interest at this point. Labor costs are difficult to estimate, so have been eliminated, and material costs given at contractors' prices:

SERVICES

	Per foot
2 No. 8 insulated wires in ¾-in conduit	12.10c
3 No. 6 insulated wires in 1-in conduit	22.39c
2 No. 6 insulated and 1 No. 6 bare wires in 1-in conduit	20.59c
2 No. 6 insulated and 1 No. 6 bare wires in entrance cable	11.90c
3 No. 4 insulated wires in 1¼-in conduit	29.88c
2 No. 4 insulated wires, 1 No. 6 bare, in 1-in conduit	22.90c
2 No. 4 insulated wires, 1 No. 6 bare in entrance cable	14.30c
3 No. 2 insulated wires, in 1½-in conduit	38.17c
2 No. 2 insulated wires, 1 No. 4 bare wire in 1¼-in conduit	31.56c
2 No. 2 insulated wires, 1 No. 3 bare wire in entrance cable	19.50c

GROUND WIRE

1 No. 8 insulated wire in ½-in conduit	8.34c per foot
Bare No. 8 armored wire	2.69c per foot
Bare No. 6 stranded wire	1.95c per foot
Ground clamp for use with conduit	75c
Ground clamp for use with bare wire	18c

SERVICE SWITCH

Old type with meter test equipment and accessible main fuses	
100 ampere	$15.60
60 ampere	9.00
30 ampere	3.90

NEW STYLE, ORDINARY FUSED SWITCH

100 ampere	9.00
60 ampere	4.13
60 ampere, combination switch with main and range fuses and 4 branch circuits	6.32
Same with 6 branch circuits	7.70

INTERIER WIRING, RANGE CIRCUIT

3 No. 6 insulated wires in 1-in conduit	22.39c per foot
2 No. 6 insulated wires and 1 No. 8 bare wire in non-metallic cable	15.00c per foot
3 No. 8 insulated wires in ¾-in conduit	14.20c per foot
2 No. 8 insulated wires and 1 No. 10 bare wire in non-metallic cable	10.40c per foot

INTERIOR WIRING, BARN LIGHTING CIRCUITS

2 No. 14 insulated wires in ½-in conduit	7.56c per foot
3 No. 14 insulated wires in ½-in conduit	8.22c per foot
2 No. 14 insulated wires in non-metallic sheathed cable	2.48c per foot
3 No. 14 insulated wires in non-metallic sheathed cable	3.91c per foot

PORTABLE MOTOR CIRCUIT

2 No. 6 insulated wires in 1-in conduit	18.65c per foot
2 No. 6 insulated wires in non-metallic sheathed cable	12.13c per foot

Of all the items here discussed, namely, service-entrance cable, grounding, entrance switches, service-entrance capacity formula, pole metering, non-metallic sheathed cable, non-metallic sheathed cable with an uninsulated neutral and the unfused main switch, perhaps no one of them will cause a decided lowering in the cost of a farm wiring installation, but, in the aggregate, they will affect this cost materially and should make it possible for the farmer to get more and better wiring for his money than has been possible heretofore.

Soil Sterilization by Electricity[1]

By I. P. Blauser[2]

SOIL STERILIZATION is becoming a common practice. The need for soil sterilization is quite evident to anyone who is attempting to grow plants or crops intensively in the same soil year after year. The field for soil sterilization may be roughly divided in two classes. The first includes greenhouse ranges and large areas, and the second includes small areas such as greenhouse ground beds and benches, hotbeds, flats, and pots.

Soil sterilization may be accomplished by any one of three general methods with varying degrees of success—steam, dry heat, or chemicals. Steam is by far the most common method, particularly where large areas or whole greenhouses are to be sterilized. Dry heat is used to some extent for sterilizing tobacco beds and for small quantities of soil. Chemicals, such as formaldehyde, acetic acid, carbon bisulfide, and various copper compounds are used, but as a general rule each has its limitations.

Sterilizing soil with electricity has received considerable attention during the past few years. Electricity is being used for sterilization by two different methods of application. One method is to use insulated electric heating elements in a soil container, which may be considered a variation of steam or dry heat sterilization depending upon the moisture content of the soil. The other method is to pass the electricity through the soil, and is known as the resistance method. Mr. Charles W. Wildebour of the Puget Sound Power and Light Company is credited with the origination and development of this method. Electricity is passed through the soil which is in contact with metallic electrodes connected to 230-volt, 60-cycle alternating current. The resistance of the soil to the passage of the current causes the soil and the soil moisture to be heated. Sterilization by the resistance method is really, then, a variation of steam sterilization. So far as is known at the present time, sterilization by the resistance method is due to the heat created, and not by the passage of the electric current through the organisms. Some work has been done with high-frequency current for sterilization, but it is still in the experimental stage.

At the present time electricity is used for sterilizing only relatively small areas, because of the large capacity electric service that would be required to sterilize a large area in a reasonable length of time, or the long period of time that would be required if the average greenhouse electric service were to be used. This applies to both methods of using electricity.

Ordinarily the larger greenhouses are so equipped that live steam sterilization is not a very great problem. The small operator, however, is not equipped for it, but usually has electric service and can, by proper management, take care of his soil sterilization needs with electricity.

The element type sterilizer has the advantages of (1) A definite, known demand; (2) all soils can be treated similarly and independently of moisture content, and (3) there is less danger in working with the sterilizer. These advantages, however, seem to be more than offset by the disadvantages of (1) higher first cost, (2) higher operating cost, and (3) very uneven heating of the soil.

The resistance type of sterilizer has the advantages of (1) low first cost, (2) lower operating cost, (3) even temperature throughout the soil mass, and (4) simple construction so that most anyone can build his own sterilizer. The disadvantages of this type sterilizer are that (1) the demand is not constant, and (2) more care must be used in working with the sterilizer, so that the operator will not come in contact with the soil or electrodes while they are connected to the electric service. The hazard, however, is not great and may be practically removed, if a safety device is used which prevents the sterilizer being opened as long as it is connected to the electric service.

There are two general plans of installing the electrodes in the wood box sterilizer. One is to use vertical electrodes spaced equally apart and varying in spacing from 2 to 10 inches with alternate electrodes connected to opposite sides of a 230-volt service. The other plan is to use only two electrodes placed horizontally in the box, one on the bottom and one on the top. The use of horizontal electrodes shown in Fig. 1 was developed at Ohio State University to overcome some of the difficulties in loading a sterilizer having vertical electrodes which had a tendency to cause uneven heating.

There are a number of factors that affect the power demand of the resistance type of sterilizer. For a particular spacing of the electrodes the power demands vary with (1) the different types of soils, sand, clay loam, etc.; (2) moisture content of the soil; (3) soluble salts present in the soil, and (4) temperature increase during sterilization.

[1]Paper presented before the Rural Electric Division at the 29th annual meeting of the American Society of Agricultural Engineers, at Athens, Georgia, June 17 to 20, 1935.

[2]Secretary and field engineer, Ohio Committee on the Relation of Electricity to Agriculture. Assoc. Mem. ASAE.

The closer the spacing of the electrodes, the greater the flow of current when the area of electrodes remains constant, and the shorter the time required to bring the soil up to a sterilizing temperature. The Ohio soil sterilizer using two electrodes has a standard soil depth of 10 inches. Fig. 2 shows typical power and temperature curves of a sandy loam soil with a 22½ per cent moisture content by weight. It will be noticed that the initial demand was 2.3 kilowatts and that the demand increased as the temperature increased, reaching a maximum demand of 10.2 kilowatts simultaneously with the high point on the temperature curve. It will also be noticed that the demand dropped off rapidly after the maximum temperature of 210 degrees (Fahrenheit) had been reached. This is accounted for by the fact that the contact resistance between the electrodes and the soil increases rapidly as the electrodes and the soil next to them become dry. Thus the sterilizer is semiautomatic in operation, if a temperature of 210 degrees is desired. The sterilizer, the operation of which is given by the curves in Fig. 2, had a soil depth of 10 inches and two horizontal galvanized iron electrodes, each 24 by 36 inches, giving a capacity of 5 cubic feet. The lid of the sterilizer fits down into the box so that, when the box is filled level full of soil and the lid then closed, 11 inches of soil is compressed into a thickness of 10 inches. This gives a good uniform contact over the entire area of the two electrodes, which is very essential to uniform heating of the soil mass. To insure a minimum of contact resistance between the soil and the electrodes, the electrodes should be moistened thoroughly just before the sterilizer is loaded. It is also important that the moisture content of soil be uniform, and best results are secured, all factors considered, when the moisture content is that at which the soil is best suited for seeding or transplanting. That will usually be somewhere between 20 and 30 per cent by weight, depending upon the organic content of the soil. If the soil is dry, the resistance is greater and the time required for sterilizing will be increased accordingly. The higher the moisture content, the less the resistance, the greater the flow of current, and the shorter the time required for sterilization. However, with wet soil the electric service may be overloaded, unless some type of current-limiting device such as a rheostat is used. There is practically no change in moisture content during sterilization by the resistance method; therefore, soil should have the proper moisture content for planting before it is sterilized.

Numerous tests have shown that the maximum demand is from three to four times the initial demand. This point should be taken into consideration when the sterilizer is being built, so that the existing electrical service will not be overloaded.

The amount of electricity used for sterilizing soil by the resistance method averages about 1 kilowatt-hour per cubic foot when sterilized at a temperature of 180 degrees. It will vary, however, with the character of soil, the temperature, and the time of sterilization. Fig. 3 shows the relationship between the temperature and energy consumption for two different types of soil.

The resistance method of electric sterilization does have some disadvantages, even though it has many advantages over the other method of using electricity, which consists of using a standard type of electric heating element. The chief disadvantage of the resistance method of sterilizing soil is the fact that the resistance of different soils vary, and the demand of the sterilizer of course will vary accordingly. The resistance type sterilizer using a depth of soil of 10 inches will usually require from 1 to 1½ hours to reach a temperature of 210 degrees; however, one sample of soil was found that at the optimum moisture content for planting required 5 hours to bring it up to that temperature. Two different methods can be used to reduce the time required. One is to decrease the depth of the soil, which would require different spacings for the electrodes, and the other is to treat the soil with a light application, 1/40 to 1/20 of one per cent, of a soluble salt such as ammonium sulphate or potassium chloride.

There is not generally, however, a very great difference in the soil that is found in any one particular greenhouse. Thus, before a resistance type of sterilizer is built, it is necessary to determine the load that can be put on the electric service without overloading it, and then test the soil as to its resistance to the flow of electricity. After these two things have been done, then the proper size of sterilizer can easily be determined.

The resistance of the soil may be tested by one of two means. One method is to build a sterilizer with a small cross-sectional area, and test the soil in it by measuring the flow of current through the soil. The other method is to determine the relative conductivity by making a soil solution of equal weights of soil and distilled water, and measuring the amount of current that flows under standard conditions. Fig. 4 shows the relationship between the initial demand of the test sterilizer and the relative conductivity of the soil solution. The test sterilizer used was 10 inches deep, had two electrodes each 10 by 10 inches, held 1,000 cubic inches of soil, and was connected to a 60-cycle, 230-volt, alternating current electric service. The relative conductivity in these tests was determined by measuring the flow of current in amperes between two electrodes of stainless steel, each 1 by 1 inch, immersed in the soil solution

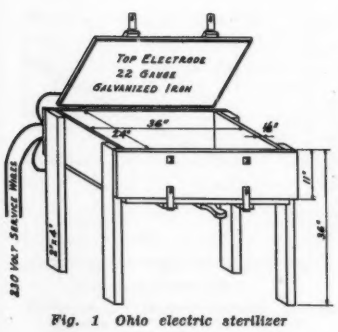


Fig. 1 Ohio electric sterilizer

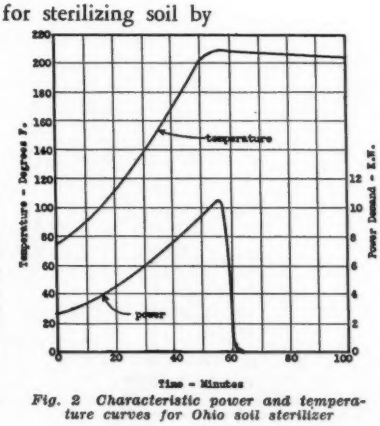
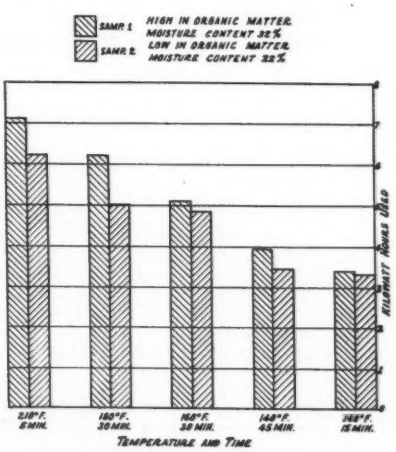


Fig. 2 Characteristic power and temperature curves for Ohio soil sterilizer


SAMP. 1 HIGH IN ORGANIC MATTER. MOISTURE CONTENT 32%
SAMP. 2 LOW IN ORGANIC MATTER. MOISTURE CONTENT 22%
KILOWATT HOURS USED
210°F. 5 MIN.
180°F. 30 MIN.
160°F. 30 MIN.
140°F. 45 MIN.
120°F. 15 MIN.
Temperature and Time
Fig. 3 Energy consumption in soil sterilization

1/8 inch apart and connected to dry cells with a combined voltage of 9 volts. The tests show that there is a direct relationship between the relative conductivity and the initial demand of the sterilizer.

It should be remembered that the maximum demand is from 3 to 4 times the initial demand, and that the flow of current is directly proportional to the area of the electrodes, and inversely proportional to the distance between them. The maximum demand of the standard 5-cubic-foot Ohio sterilizer is about 10 kilowatts. Should the electric service permit a maximum load of only 5 kilowatts, the demand of the sterilizer could be limited to that by reducing the area of the electrodes one-half, but keeping the depth the same. This of course would reduce the capacity to 2½ cubic feet. The sterilizing time would remain the same. The demand may also be limited to 5 kilowatts by increasing the depth of the soil to 20 inches, and not changing the area of the electrodes. In this latter case the capacity would be increased to 10 cubic feet, and the time required for sterilization would be four times as long, since the demand has been reduced one-half and the capacity doubled. If the sterilizer were 24 by 18 inches and 5 inches deep, the capacity would be 1¼ cubic feet, the maximum demand 10 kilowatts, and sterilizing time would be only one-fourth that required for the 10-inch depth.

The general requirement having been determined, some variation in demand and sterilizing time may be overcome by varying the moisture content, or by adding soluble salts. Fig. 5 shows the relationship between the moisture content of soils and their conductivity. Fig. 6 shows the relationship between the percentage of potassium chloride added to two samples of soils and the resulting conductivity.

Where relatively small amounts of sterilized soil are needed, the resistance method of electric soil sterilization has proven quite satisfactory. It is being rather generally accepted, and is given preference over the heating element type of electric sterilizer because of the much cheaper first cost and operating cost, and more even temperature secured.

There are several makes of soil sterilizers using heating elements. They may be purchased as a complete unit, or the heating elements alone may be purchased and the sterilizer constructed according to plans furnished with the elements. The capacities of the complete sterilizers vary from ⅓ to 1 cubic yard, have a demand of from 1250 to 5000 watts, and list at $85 to $135. One company is offering heating elements of 750 watts, listing at $11 each in lots of four, to be used in a homemade sterilizer. Plans sent with the elements specify four elements for a sterilizer with a capacity of ½ cubic yard.

Tests have been made on two element type sterilizers, one with a demand of 5000 watts and a capacity of one cubic yard, and the other with a demand of 1250 watts and a capacity of ⅓ cubic yard. The larger sterilizer was on for 9 hours, and at the end of that time the lowest temperature in the sterilizer was 158 degrees, while the highest temperature at the same time was well over 300 degrees. Three hours after the current was turned off the temperatures at the two thermocouple stations were 150 and 252 degrees, respectively, and 12 hours after the current was shut off the temperatures were 106 and 180 degrees, respectively. The amount of energy used was 45 kilowatt-hours, or 1.7 kilowatt-hours per cubic foot.

The smaller sterilizer was on for 10 hours, and at the end of that time the lowest *(Continued on page 440)*

TABLE 1. SOIL STERILIZED BY RESISTANCE TYPE ELECTRIC STERILIZER

Pot No.	Temperature degrees F	Weeds	Plant No.	Nematodes	Fusarium wilt
1-A	210	None	1-A-1	None	None
			1-A-2	None	None
1-B	210	None	1-B-1	None	None
			1-B-2	None	None
2-A	180	None	2-A-1	None	None
			2-A-2	None	None
2-B	180	None	2-B-1	None	None
			2-B-2	None	None
3-A	150	None	3-A-1	None	None
			3-A-2	None	None
3-B	150	None	3-B-1	None	None
			3-B-2	None	None
4-A	140	None	4-A-1	None	None
			4-A-2	None	None
4-B	140	None	4-B-1	None	None
			4-B-2	None	Severe
5-A	130	None	5-A-1	None	Severe
			5-A-2	None	Severe
5-B	130	Few	5-B-1	None	None
			5-B-2	Few	None
6-A	120	Many	6-A-1	Few	Severe
			6-A-2	Many	Severe
6-B	120	Few	6-B-1	Few	Light
			6-B-2	Few	Light
Check A		Many	C-A-1	Many	Severe
			C-A-2	Many	Severe
Check B		Many	C-B-1	Many	Severe
			C-B-2	Many	Severe
Check C		Many	C-C-1	Many	Severe
			C-C-2	Many	Severe

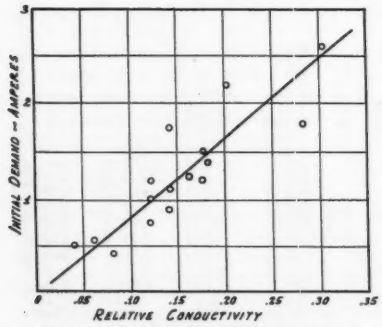


Fig. 4. Initial power demand compared with relative conductivity

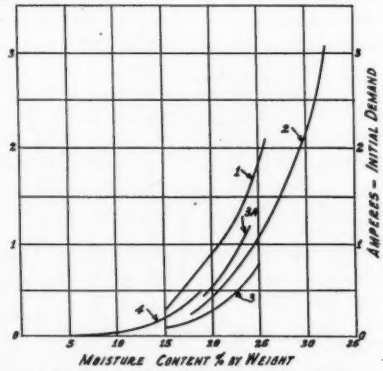


Fig. 5 Relation between initial power demand and moisture content

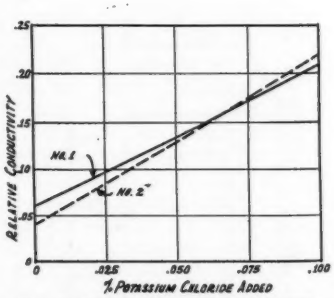


Fig. 6 Relative conductivity compared with soluble salts in soil solution

Specific Gravity and Air Space of Grains and Seeds[1]

By Frank. J. Zink[2]

THE SEPARATION of seeds is accomplished by several methods. One of these methods is by the use of different liquids of varying specific gravities. Two or more kinds of seeds, other physical characteristics being equal, may be separated because of variations in specific gravities (4)[3]. A liquid of suitable specific gravity will, when mixed with the grain, cause the low-gravity seed to float and the higher-gravity seed to settle out of the mixture. This means may in some specific cases be the only method available which will accomplish the desired separation. There appears to be a need for data on the specific gravities of seeds and grains.

Also in the process of drying grain by forced air draft, where it is desired to present data on the number of air changes per unit of time, there is needed information on the approximate percentage of void space within the interstices of the grain or seed. Various investigators have engaged in grain drying and grain-bin ventilation, but without consideration of the actual quantity of air enmeshed. It is thought that such information would be helpful to the calculations involved.

Both of these phases deal with fundamental information which is of use to the agricultural engineer. They are treated together here for the reason that, in the ordinary specific gravity determination, the relation of enmeshed air to volume is one of the functions of the calculation. Or if one were to determine air space in a given volume of grain, perhaps the best means at hand is the commonly used method of finding the specific gravity, especially as it relates to granular substances.

A review of literature shows practically nothing available on either specific gravity or air space of grains. The specific gravity of wheat as related to milling and baking qualities has been studied for many years, and the specific gravities and variations of this particular grain are very well known. One of the chief contributors on this subject is Bailey (1) who also has improved upon the method of measuring specific gravity, Bailey and Thomas (2). One source of information found presents data which is plainly in error in respect to specific gravity reported (5).

In discussions relating to granular substances, there exists some confusion of the terms "density" and "specific gravity." In fact, the confusion of the two terms may be because of the commonly used definitions. "Density" according to Veazey and Hodgemann (6) is "concentration of matter, measured by mass per unit volume, expressed as grams per cubic centimeter," that is, in the centimeter-gram-second system. According to Carhart (3), "the density of a body is the number of units of mass it contained in a unit of volume, or $d = m/v$, where d is density, m is mass, and v is volume."

Also (6) "specific gravity" is expressed as "the ratio of mass of the body to the mass of an equal volume of water at 4 degrees Centigrade." According to Carhart (3), "the specific gravity of a body is the ratio of the mass of any volume of it to the mass of the same volume of pure water at 4 degrees Centigrade." In the cgs system the specific gravity of solids and liquids is numerically equal to their density.

Doubtless following these definitions, Fischer (5) reports the cereal wheat as having a specific gravity of 0.77. However, it is common knowledge that wheat sinks in water. An anomaly exists here. The apparent fault is the confusion of the terms "specific gravity" and "density." Quite obviously, what is meant by Fischer in reporting the value 0.77 is density of a unit volume. This figure was doubtlessly arrived at by comparing the weight of a cubic foot of wheat with that of a cubic foot of water at 4 degrees Centigrade. This ratio is 48 to 62.428, or 0.7688. Hence the material reported by Fischer relates to the density of a unit of volume rather than to specific gravity.

Densities of units of volume are important from the standpoint of calculation of strength requirements of storage buildings, and such densities may not be computed from information on specific gravities without due consideration of air space involved in the granular substance.

The method used in this study is one commonly used for the specific gravity determination of a solid which is available in small fragments. It is similar to that used by Bailey and Thomas (2) and Bailey (1). In this determination none of the ordinary specific gravity bottles were thought suitable for the measurements of both specific gravity and per cent of air space. Therefore an ordinary wide-mouthed bottle was chosen, such that the side of the neck section was practically flush with the side of the bottle. This provided that the seeds would completely fill the space next to the neck section. The bottle was closed with a rubber stopper fitted with a washer so that it could be placed in the bottle a fixed distance in each experiment. The method involves three operations: (a) Weighing the bottle containing the solid with air, W, (b) weighing the bottle full of liquid, W_1, and (c) weighing the bottle containing the solid filled up with the liquid, W_2. It is obvious that $W + W_1 - W_2$ is the weight of the liquid displaced by the solid and is the weight of an equal volume of liquid.

The relative density is

$$\frac{W}{W + W_1 - W_2}$$

The volume of enmeshed air is readily seen to be W_2 divided by the specific gravity of the liquid used, or

$$\frac{W_2}{\text{specific gravity of liquid used}} = V_A$$

and

$$\frac{V_A}{V} \times 100 = \text{per cent of air space}$$

where V_A is air volume and V is the original volume of bottle.

The volume of the particular bottle chosen measured 185 cubic centimeters, and the liquid used in the determination was mercury.

In the selection of this method of measurement of speci-

[1]Contribution No. 65, Department of Agricultural Engineering, Kansas Agricultural Experiment Station.

[2]Agricultural engineer, Kansas Agricultural Experiment Station. Mem. ASAE.

[3]Numbers in parenthesis refer to literature cited at the close of this paper.

TABLE 1. GRAIN DENSITY AND AIR SPACE DETERMINATIONS

Grain	Variety	Specific gravity	Per cent of air space	Per cent of moisture, wet basis
Wheat, hard	Turkey, winter	1.30	42.6	9.8
Wheat, hard	Turkey, winter (yellow)	1.29	40.1	9.8
Wheat, soft	Harvest Queen	1.32	39.6	9.8
Oats	Victory	1.05	47.6	9.8
Oats	Red Texas	0.99	55.5	10.3
Oats	Iowar	0.95	51.4	9.7
Oats	Kanota	1.06	50.9	9.4
Barley	White Hulless	1.33	39.5	10.4
Barley	Svansota	1.21	45.4	9.8
Barley	Coast (6 row)	1.13	57.6	10.3
Barley	Trebi (6 row)	1.24	47.9	10.7
Barley	Hanchen	1.26	44.5	9.7
Soy beans	Manchu	1.18	36.1	6.9
Soy beans	Wilson	1.13	33.8	7.0
Grain sorghum	Yellow milo	1.22	37.0	9.5
Grain sorghum	Blackhull Kafir	1.26	36.8	9.9
Rye	Common	1.23	41.2	9.7
Rice	Honduras	1.11	50.4	11.9
Rice	Wataribune	1.12	46.5	12.4
Flax		1.10	34.6	5.8
Corn, No. 1	Mixed yellow and white	1.19	40.0	9.0
Buckwheat	Japanese	1.10	41.0	10.1
Millet	Siberian	1.11	36.8	9.4

fic gravity rather than the more precise means as suggested by Bailey and Thomas (2), it was considered that the additional refinement was unnecessary. The only manner in which the method of Bailey differs from the above is that he provided for the aspiration of the air confined in the creases and coverings of the grain such as the brush of the wheat kernel. The probable difference by not aspirating the air from wheat is about 0.1 lower in specific gravity. The measurements were made at normal room temperatures, approximately 70 degrees Fahrenheit.

The use of the liquid separation by specific gravity differences has not been widely applied in commercial practice. The practicability of the process depends greatly on the equipment evolved. However, in the case of small quantities of seeds the equipment need not be elaborate. Also, where confined to seeds of high intrinsic values or for the elimination of obnoxious weed seeds from seed of high value, the method possesses some special value.

TABLE 2. CALCULATED DENSITIES OF SEEDS BASED ON LEGAL WEIGHT BUSHEL
(Bushel volume, 1¼ cubic feet)

Grain or seed	Legal weight of bushel, pounds	Pounds per cubic foot	Density of a unit of volume*
Alfalfa seed	60	48.0	0.7688
Barley	48	38.4	0.6151
Beans	60	48.0	0.7688
Bluegrass seed	14	11.2	0.1794
Buckwheat	48	38.4	0.6151
Clover seed	60	48.0	0.7688
Corn, shelled	56	44.8	0.7176
Millet, seed	50	40.0	0.6407
Oats	32	25.6	0.4100
Rye	56	44.8	0.7176
Timothy seed	45	36.0	0.5766
Wheat	60	48.0	0.7688

*Compared with water at 4 degrees Centigrade—62.428 pounds per cubic foot.

Table 1 presents results obtained for a series of different grains. Table 2 presents data on the relative densities of various grains calculated from the legal bushel weight in common use for the grain.

It should be pointed out that there is some variation of specific gravities as well as air space. Specific gravities vary for different stocks of seeds. Air space varies in different storages, depending somewhat on depths of grain, maturity, and other physical differences.

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Soil Sterilization with Electricity

(Continued from page 438)

temperature in the sterilizer was 163 degrees and the highest 298 degrees. Two and one-half hours later the low and high temperatures were 169 and 224 degrees, respectively. From that time on every thermocouple station showed a drop in temperature. The sterilizer used 12.5 kilowatt-hours, or about 1.3 kilowatt-hours per cubic foot.

Sterilization of benches and ground beds by the resistance method is not as satisfactory at the present time as the box sterilizer, but it can be accomplished by using either horizontal or vertical electrodes in the beds or benches. There is some loss of current, which increases the energy consumption.

Where steam sterilization has been used the general recommendations have been to steam soil at a temperature of 210 degrees for 3 to 4 hours. No doubt this length of time was recommended to insure that all of the soil mass be raised to sterilizing temperature. With the resistance type of electric soil sterilization it was found that the temperature variation throughout the soil mass varied only a few degrees when recommendations for its use were followed. Several series of tests have been run by A. L. Pierstorff and the author at Ohio State University to determine the minimum temperatures required for the control of nematodes and fusarium wilt organism. Tomatoes were grown in all these series. The result of the third series is shown in Table 1. The first and second series of tests were not consistent, because of recontamination in some of the pots after sterilization. In the third series special effort was used to prevent recontamination. This third series indicates that a temperature of 150 degrees will control fusarium wilt organisms and that a temperature of 140 degrees will control nematodes and weeds. The first and second series indicates that a higher temperature is required to kill weed seeds, and that a lower temperature may be effective for nematodes. In the third series of tests the soil was dumped and put into pots as soon as the required temperature was reached. The temperatures varied from 210 to 120 degrees. The pots were treated with a solution of formaldehyde before the sterilized soil was placed in them. The soil was sterilized December 13 and 14, 1934, and the tomatoes harvested and the results read May 11, 1935. The investigation is to be continued.

An Engineered Education[1]

By John T. Wheeler[2]

IN REVIEWING the devastation of the World War shortly after its close, H. G. Wells, the noted English novelist, wrote a sentence regarding education that challenged the attention of thinking men throughout the civilized world. This is the sentence: "Civilization is a race between education and catastrophe."

This commanding statement places education as the active social agency standing between organized society on the one hand and the forces of social disintegration on the other. American educators seized upon this idea and commented favorably on the wisdom of its author. They patted themselves on the back, as it were, because the social worth of their profession was frankly recognized by a writer of so wide repute. After more than a decade of rapidly changing human events since the penning of the line just quoted, Mr. Wells speaks again. He now says that he used the "wrong figure of speech" in his former statement. He contends however that it was all right to use in this sentence the words "education" and "catastrophe" for these ideas were both in the picture, but it was wrong to use the word "race," for, he says, "there was no race," and there is yet no race!

Catastrophe has advanced apace and it is literally upon us, but education, he points out, is "loitering by the way and rotting down to disaster. Education is not being beaten in an honorable struggle." There is no struggle; there is no race between education and catastrophe. Wells does not stop with this statement, however; he continues, "Education should face this fact, accept the challenge, and get into the race on a new basis."

This is a sharp and jolting criticism. Yet we recognize the fact that education does not keep abreast of the rapidly moving order of things. Particularly as it affects rural America, education sadly lags, if it does not actually loiter; traditionally, education is stale and musty, if not actually rotting down to disaster. We are beginning to believe that, if education through the agency of our public schools and colleges longer withholds from the struggle of rural social reconstruction, other agencies must be developed to enter the lists on the side of rural civilization. In fact, during the past two decades, several important nation-wide agencies have been developed outside our schools and colleges to meet the educational needs of rural dwellers. At this moment, still other agencies are being promulgated on a nation-wide basis to aid the cause of rural life because institutionalized education continues to loiter or is definitely "bogged down." We are beginning to recognize that something must be done to put education in the race and keep it there on an "honorable basis."

The new basis upon which education should enter the race may well be termed an "engineered education," because the word "engineer" means to invent or be able to deal with inventions. Never before in the history of this country have we so much needed inventive genius in the field of public education. Schools and colleges must find new ways of attacking educational problems, or they will lose even that which they have. The questions before them are: Can schools and colleges invent educational programs that will meet the challenge of this day; can they invent programs that will take education out of the bogs of tradition and place it in the race to meet the needs of rapidly moving human events? If they can make such inventions, civilization may be rescued from catastrophe by their efforts. Nothing, however, short of ingenuity and invention on the part of our schools and colleges can place education in the race against social disintegration.

Now, if engineering in education is so much needed, as I believe it is, how can the administrators of education invent effective programs and processes that will definitely put education in the race to meet the social emergency?

AIM A BEGINNING POINT

First of all, an engineered education must know where it is going. Modern road engineers do not just lay out routes; they lay a route between definite points. In laying out U. S. route No. 1 from Washington, D. C., southward, the engineers aimed to connect the national capital with the southernmost city on the Atlantic seaboard, and northward they aimed to connect the nation's capital city with the northernmost town on the east coast of the United States. When the route was once determined, an improvement program extending over many years was planned. Just so with an engineered education, when we know where we are going, we can lay out long-time programs of educational development.

You may well ask: Where are we going in education? Wells says we aren't going; we are standing still, and that is the trouble. He says we are bogged down in the morass of tradition. You may then put the question this way: Where should we be going or what should be the aims or goals of education towards which to move? This question is too large to be adequately answered in this discussion, but this question must be frankly faced and answered before we can have an engineered program of education. Although this question cannot be fully treated in this brief discussion, still I shall not sidestep the issue. I shall attempt to take one aspect of the problem as an example and go ahead.

I believe with Dewey that "one of the chief aims of education is to equip individuals to take an active concern in bettering conditions in our institutions." This statement of aims recognizes the place that institutional life holds in any broad-gauged democratic program of education. That is, it recognizes the fact that individuals grow and develop, not in isolation, but in and through institutional contacts and controls. It recognizes the fact that education (growth and development) goes on in the home, the neighborhood, the church, the pursuit of farming, and in any and all other vocations, quite as truly as, and perhaps more definitely, than in the schools themselves. This statement of aim also recognizes the fact that individuals must become actively engaged in bringing about improvements of conditions in our institutions as the only sound basis of progress. Such an aim provides for evolution through education and not evolution by revolutionary measures.

If an engineered education would put such an aim into practice, it must do three things: First, it must analyze "institutional betterment" into its objective factors in terms of American institutional conditions and standards; secondly, it must develop a working philosophy of education that

[1]An address before the College Division at the 29th annual meeting of the American Society of Agricultural Engineers, at Athens, Georgia, June 17 to 20, 1935.

[2]Professor of education, The University of Georgia.

will point the way to institutional betterment, and, thirdly, it must develop programs of education that will give individuals the necessary abilities to deal effectively with the problem involved in institutional betterment.

AN ANALYSIS IN TERMS OF AIM

Now I am sure that any one of you, as an agricultural engineer, could make an objective analysis of "institutional betterment" in terms of rural life that would reveal many of the vital factors of institutional betterment which imply educational need. As engineers you would most likely include in your analysis such factors as the following: (1) Providing better sanitary facilities in homes, in neighborhoods, in schools, in the productive aspects of farming and so on; (2) providing better institutional lighting facilities including electricity; (3) providing better institutional heating facilities; (4) providing better equipment and appliances in the home, in the school, and on the farm; (5) providing better methods and facilities for the conservation of food in the home or in the community and feeds on the farm; (6) providing recreational and play facilities for the home, the neighborhood, and the school; (7) providing means for the construction and repair of farm and home and community buildings; (8) providing means for the repair of home and farm tools and equipment; (9) providing ways and means of conserving our soil. And so on and on your objective analysis might go in developing factors dealing directly with the improvement of our rural institutions.

"The betterment of rural institutions" is a vital aim particularly for rural education and for agricultural engineers; it can put education in the race against the forces of social disintegration and keep it there on an honorable basis. Of course the kind of factors for institutional betterment which we have enumerated above are the ones that I assume would appear most obvious to the agricultural engineer. Anything like a complete objective analysis of this aim of education, however, would reveal hundreds and hundreds of other problems dealing with all aspects of rural institutional betterment. Such an analysis would include all phases of the social, health, recreational, citizenship, economic, and aesthetic aspects of institutional improvement.

While a complete analysis in terms of our aim is much to be desired in developing engineered programs of education, still beginnings can be made without such complete analyses, providing we always keep in mind the ultimate goal of "institutional betterment" and the guiding principles that point the direction in which to make changes. We can better American institutions in many, many definite ways without comprehending the whole problem, but we must always plan and measure what we do in terms of our aim and our ideals of betterment.

A GUIDING PHILOSOPHY

An engineered education then must have not only a definite aim, but it must also have an objective analysis in terms of that aim. That is one of the main points for you to hold. The aim is the goal towards which all educational organization should move; the analysis is the preliminary survey that reveals intermediate objectives and determines the educational route to be travelled in reaching the ultimate goal. The aim and the intermediate objectives are not enough. There must be a guiding philosophy in dealing with the objective problems revealed by the analysis.

We should recognize that there is a difference between mere institutional change and institutional betterment. It is true that change is necessary to progress, but it is also true that all change is not necessarily moving in the direction of institutional betterment at a given time; therefore, the necessity of a philosophy to give guidance and direction to institutional changes. Sociologists tell us that we may use the following criteria as a basis of measuring progress in institutional change: (1) "If changes make for better *health,* they are in the right direction," (2) "if changes make for more wholesome *recreational* opportunities, they are in the right direction," (3) "if changes make for more *beauty* in our institutions, and in our surroundings, the changes are in the right direction," (4) "if changes make for improved ways of carrying on *economic* activities, they are in the right direction," (5) "if changes make for better civic *relations* in our institutional life, they are in the right direction," and, (6) "if changes make for better *social* relations, they are in the right direction."

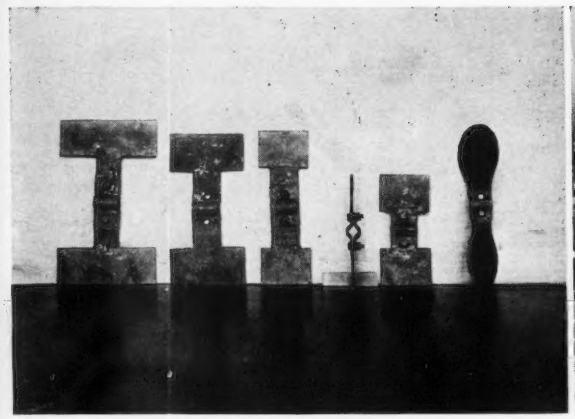
Out of years of experience in training vocational teachers, we have long since ceased to send men and women out to teach agriculture or homemaking as subjects. We send them out to improve homes as institutions; teachers of agriculture go out to improve farming as an institution. These groups of teachers are faced also with the problems of improving communities as institutions. We can measure the success of these teachers in terms of what they get people to do with the problems of institutional betterment —health betterment, economic betterment, recreational betterment, etc., etc.

Teachers must go out armed not with textbooks, in which they find their problems for teaching, but they must go out armed with the point of view and method of the educational engineer. Through an analysis of the institutional problems, agriculture, homemaking and rural community life, teachers discover their teaching units. When these institutional problems are discovered in terms of specific communities, farms, and homes, teaching programs are set up to get men, women, boys, and girls to concern themselves with these problems to the end that their institutions may be improved in specific ways and in given directions. These teaching programs include hundreds of problems dealing with crop and animal production in specific types of farming; home and farm improvements, feeding and clothing the family in terms of definite homes; human relations in the various aspects of social life; child care and development; community improvement and so on almost without end.

ABILITIES MUST BE DEVELOPED

Not only do teachers who deal with the idea of "engineered education" analyze the institutional life and activities to discover teaching problems, and develop courses to get individuals "to concern themselves about these problems," but they also very definitely develop on the part of the individuals the abilities necessary to cope with the difficulties involved in each problem taught. For instance, they hold, it is one thing to teach *about* making a septic tank, and quite another thing to develop the abilities necessary *to make,* in the most approved and economical manner, a septic tank for a given home. When institutional betterment is our aim, education cannot stop with teaching *about* a problem, it must develop the necessary abilities on the part of those taught to get the improvement accomplished according to given standards and in given directions.

Perhaps as agricultural engineers, you are in a particularly fortunate position to apply the principles of "an engineered education" in your own fields of work. You certainly may well take "rural institutional betterment" as your ultimate aim or goal. This aim would give you guidance whether your special field be teaching or research. Thorough objective analyses of the factors *(Continued on page 445)*



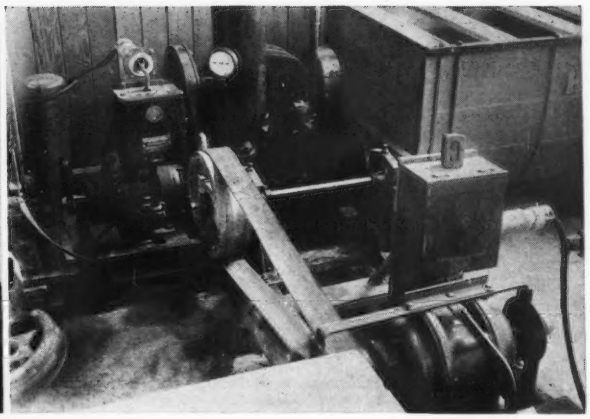


Fig. 1 (Left) Various sizes of flat agitator blades and a large propeller blade. Fig. 2 (Right) Electric motor and testing apparatus installed on a 200-gallon spray tank

Tests of Flat Steel Agitator Blades

By K. R. Frost[1]

SINCE OIL SPRAYS have come into general use as insecticides and fungicides, several methods have been used to uniformily mix the oil with the other ingredients. Oil has a tendency to remain on the surface of the liquid unless the agitation is sufficient to bring it in contact with the agitators where it may be finely divided and remain in suspension. It was thought necessary at first to increase the agitator shaft speed in order to obtain a uniform tank mix. However, this resulted in several difficulties such as greater energy consumption and costly equipment. These speeds were also too high for other sprays that may be used in the same machine, hence frequent mechanical changes are necessary.

A new type blade was suggested and tried by A. D. Borden, assistant entomologist in the agricultural experiment station at the University of California. This was a flat steel blade much larger in area than those previously used. Heretofore all orchard sprayers have been equipped with a narrow propeller blade that created movement of the liquid parallel to the axis of the shaft. The flat blade sets up a motion at right angles to the shaft which is necessary in order to disturb the oils floating on the surface. This rolling motion carries the lighter particles under the surface where they are violently agitated by direct contact with the blades.

The use of the flat blades has been chosen as the best method of agitating oil sprays because (1) agitation is more uniform, (2) there is lower energy consumption, (3) power transmission is less complicated, and (4) conversion from existing equipment is least expensive.

Tests have indicated that the energy consumption varies as the 2.5 power of the speed. Therefore, high speeds prohibit the use of small gas engines with such equipment. The flat steel blade can be used in most cases without an increase in speed and with only a very slight increase in energy consumption. The operator can make these blades or have them made at very low cost. It is also much simpler to remove the blades, if other sprays are used, than it is to change the speed. A complete set of tests has been made on the flat blade by J. P. Fairbank, extension specialist in agricultural engineering, and the author.

The uniformity of mixture resulting from the use of these agitator blades was determined by operation with a water-oil mixture containing an oil soluble aniline dye. By sampling the liquid issuing from the spray gun an accurate determination was made of the proportion of oil in each sample at various levels of liquid in the tank, hence giving a check on the amount of oil actually emulsified with the water. Kerosene was found to be an oil suitable for test purposes and was added in the ratio of 1 gallon to 100 gallons of water in the tank.

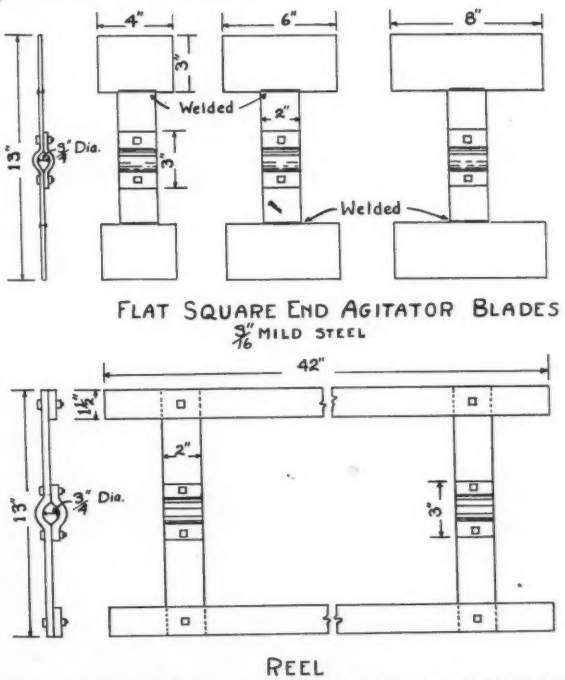


Fig. 3 Dimensional sketches showing plan and side views of flat blades and reel

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Previous tests with the standard blades at high speeds indicated that uniform mixtures resulted when the free oil disappeared from the surface of the water within several minutes. This method was followed for most of the tests run on the flat agitator blades.

Since a measurement of the energy input to the blades offers some indication as to the uniformity of mix, a method of measuring the horsepower output to the agitators was devised, and at each run this was measured and recorded. As the agitators were operated by an electric motor, it was only necessary to measure the electric energy consumed and subtract the motor and mechanical losses in order to determine the net input. A variation in speed was obtained by changing pulleys on the speed reduction unit, enabling the agitator shaft to be operated at from 75 to 220 rpm, which covered the required speed range.

The agitator blade equipment used for the tests is shown in Fig. 1, compared with a standard propeller type blade. This blade is constructed of 3/16-inch mild steel, in widths of 4, 6, and 8 inches. The length of the blade will vary with the distance from the shaft to the bottom of the tank as the blade must clear the tank bottom 1/8 to 1/4 inch. The blades were equally spaced on the shaft and at right angles to each other.

The following items were recorded during each test:

1 Speed of agitator shaft
2 Time interval until all oil disappeared, or to 10 minutes
3 Volume of water in tank
4 Number of blades, sizes, etc.
5 Remarks on appearance of free oil on the surface of the liquid
6 Electric meter reading
7 Number of sample taken.

The tests were run on the blades in two sizes and shapes of tanks in order to determine the effect of depth, width, and tank contour upon efficiency of agitation. These tanks were a cylindrical-bottom, 200-gallon tank, 33 inches deep, 36 inches wide, and 44 inches long, and a round-cornered rectangular 300-gallon tank, 42 inches deep, 34 inches wide, and 50 inches long. The agitator shaft in the former was 7 inches above the bottom and 8 inches in the latter.

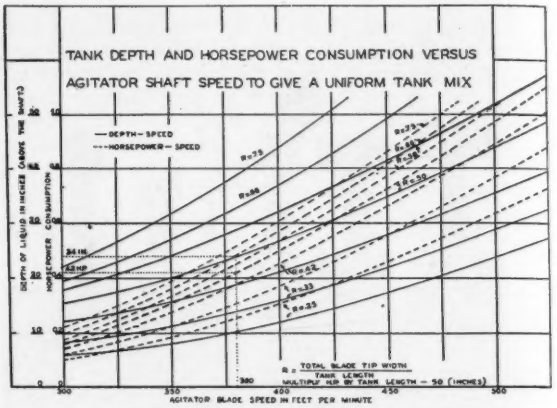
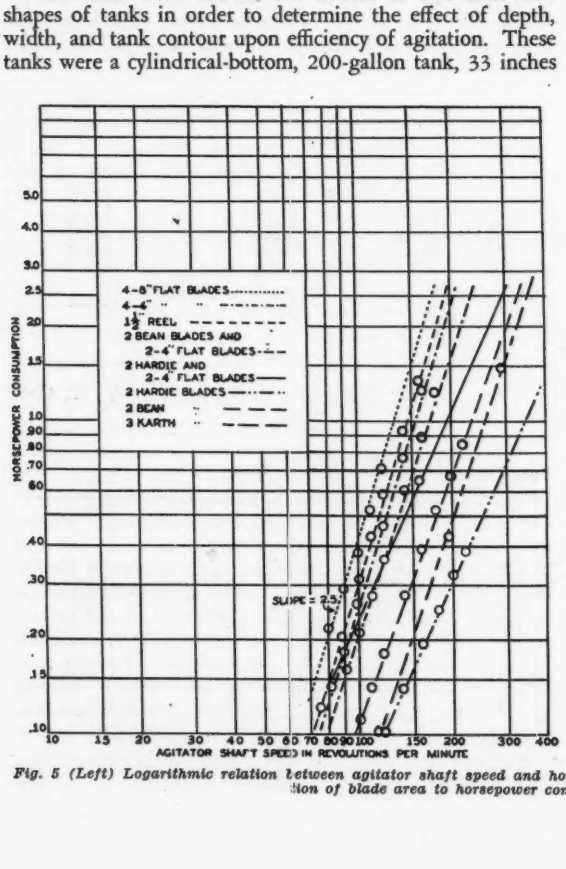

TANK DEPTH AND HORSEPOWER CONSUMPTION VERSUS
AGITATOR SHAFT SPEED TO GIVE A UNIFORM TANK MIX
—DEPTH—SPEED
---HORSEPOWER—SPEED
AGITATOR BLADE SPEED IN FEET PER MINUTE

Fig. 4 Spray tank agitation chart developed from tests of flat steel blades in a 300-gallon rectangular tank

Tests were also made on a steel reel shown in Fig. 3 in the 200-gallon tank to determine the practicability of its use in tanks where the shaft is very close to the bottom. Results of this test are given in Table 1. The use of this type of agitator requires that standard equipment be removed which is not necessary for the 4, 6, and 8-inch blades. The table also shows results with the shaft equipped with standard propeller blades and flat blades. A complete series of tests was run on all combinations of steel blades, possible speeds, and liquid depths in the rectangular tank. The results obtained from this work were plotted on the chart in Fig. 4, the use of which enables one to estimate the speed, energy consumption, and blade equipment neces-



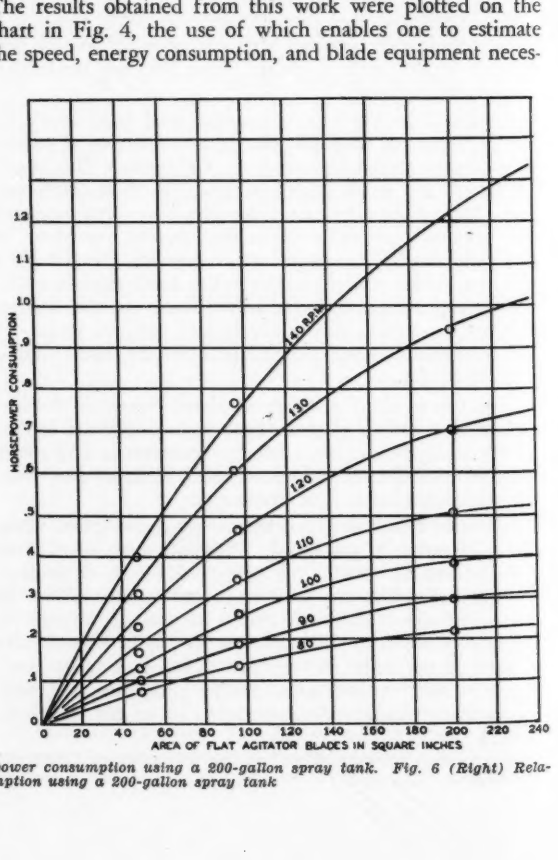


Fig. 5 (Left) Logarithmic relation between agitator shaft speed and horsepower consumption using a 200-gallon spray tank. Fig. 6 (Right) Relation of blade area to horsepower consumption using a 200-gallon spray tank

sary for any spray tank. In order to use this chart with cylindrical-bottom tanks, 80 per cent of the speed should be taken as agitation is more effective than in the rectangular tank with round corners.

Assume the following problem to be solved by the accompanying chart (Fig. 4): Cylindrical-bottom tank; width, 44 inches; length, 40 inches; shaft, 6 inches above bottom; liquid level, 30 inches above shaft. Find the speed required to agitate oil spray, size and number of blades, and energy consumption. Solution: Blades must be 11 inches long in order to clear bottom of tank. Reading the chart horizontally at the 30-inch depth to R = 0.5 on the solid line, we find the peripheral speed of the blade tip must be 420 feet per minute, or a shaft speed of 145 rpm with an 11-inch blade. Since the tank has a cylindrical bottom, multiplying the speed by 80 per cent results in a speed of 118 rpm, or 336 feet per minute tip speed. To find the energy consumption read upward on the chart from 336 feet per minute to the broken line R = 0.5, thence horizontally to the horsepower scale giving 0.27 hp. As the tank is only 40 inches long, this figure must be multiplied by 40/50. The ratio of tip width to tank length being chosen as 0.5, or 20 inches of blade width, it is necessary to use five 4-inch blades. It is unnecessary to consider the width of the tank as the effect upon agitation is slight. The results then are: Speed = 118 rpm; horsepower = 0.216; number of blades = 5 (4 by 11 inches).

TABLE 1. AGITATION TEST OF FLAT BLADES IN A 200-GALLON TANK

Test No.	Speed, rpm	Volume, gal	Horsepower	Blade equipment	Remarks
1	76	200	0.13	Reel	Free oil visible at 6 min (Unsatisfactory)
2	96	200	0.21	Reel	No free oil at 1 min (Satisfactory)
3	88	200	0.17	Four, 4-in	Free oil visible at 2 min (Unsatisfactory)
4	96	200	0.19	Four, 4-in	No free oil at 1 min (Satisfactory)
5	88	200	0.28	Four, 8-in	No free oil at 1 min (Satisfactory)
6	108	200	0.19	Two propeller, and two 4-in	No free oil at 1 min (Satisfactory)
7	96	200	0.11	Two propeller, and two 4-in	Free oil visible at 3 min (Unsatisfactory)

An Engineered Education

(Continued from page 442)

of institutional betterment would yield valuable aid in developing programs of research, and in giving functional materials for your teaching whether you are training farmers, teachers, or special technicians.

I am quite sure that the men and women manning the departments of agricultural engineering in our state colleges of agriculture, our state universities, and our federal department of agriculture, will agree with me that the aim of "rural institutional betterment" should be your aim and that out of an objective analysis of this large problem you would find your specific problems for research and teaching. You will also agree with me that those whom you train, will in turn go out armed not with textbooks or lecture notes as the source from which to select problems on which to base educational programs, but they will go out armed with the ability to discover institutional problems in their actual setting and plan educational programs to solve those problems in the situations in which they are found. In other words, you will send out educational engineers as well as agricultural engineers.

SUMMARY

In this brief discussion I have tried to point out to you that institutionalized education is being criticized as never before for its lack of virility in meeting the challenge of our rapidly changing social order. Wells says that traditional education is now out of the race as a champion of the forces for civilization. But I have suggested to you that education can be put back into the race, by taking the outlook of the engineer—the inventor and manipulator of inventions in educational programs. We must have educational engineers!

I have said an engineered education (1) will set up definite aims; (2) it will analyze its aims into their objective components to discover ways of attaining these aims; (3) it will have a philosophy for dealing with the problems discovered by and through analyses of its aims, and (4) it will set up programs of education guided by its accepted philosophy, that will accomplish the aims set up.

I have suggested that "institutional betterment" might well be considered as one of the vital aims of an engineered rural education. For it seems to me that rural institutions and institutional life are much in need of betterment and that they can be continuously bettered as long as man is able to invent means of progress in the realms of health, social adjustment, recreational facilities, citizenship ideals, and economic endeavor. It also seems to me that programs of education can be developed that will get our rural people to concern themselves with such institutional betterment.

An engineered education as it faces this vital aim of institutional betterment will not deal with traditional subject matter *per se,* but it will deal with the actual problem growing out of an analysis of institutional life and living. Around these problems, functional materials will be organized, not to teach *about* the problems involved, but to give those taught the abilities necessary to solve these problems for themselves.

Engineers, let's put rural education into the race on the basis of an engineered education!

Where the Agricultural Engineer Fits into the Picture

THE AMAZING march of organic industrial chemistry gives every promise of conquering the technical obstacles that stand between the farm as a producer of industrial raw materials and the factory as a consumer thereof. That Ford is making distributor caps and similar parts from soybean protein, and painting his cars with soybean oil, is an inkling of what may be done by resolute research and industrial vision. The real obstacles to industrial markets for the farm are economic. It is one thing to devise a process for making paint from soybeans, or insulating board from cornstalks, and another thing to get the raw material produced and delivered to the factory door at costs low enough to make the process commercial and thereby create an industry.

Rural Electrification in the United States[1]

By J. P. Schaenzer[2]

A TRAVELER finds the countryside dotted with farms, rural residences, churches, schools, country stores, gasoline filling stations, and many other commercial and industrial enterprises. In strictly agricultural areas the farms will lead the list in numbers, while in many of the eastern states the rural non-farm homes actually exceed the number of farms. All of these groups are dependent upon one another for a livelihood and are of a mutual helpfulness to each other in making the community a better and more desirable place in which to live. The relation of the farmer to the merchant, banker, professional man, tradesman, laborer, and all the others could serve as the theme for an interesting and lengthy discussion. However, for the present purpose it is merely desired to point out that our rural population is made up of all the groups and that all combined form a unit which for many purposes must be treated in its entirety.

This is true in considering rural electrification. The various rural establishments are so interrelated that it is impossible to electrify one or several groups and not electrify the others. In fact, to serve all of them is highly desirable. This tends to increase the number of customers, as well as the energy consumption and income from rural distribution lines. Rural electrification is a mutual problem in which all the rural groups are involved, and, therefore, it should be considered as a community project. If all the people living adjacent to the proposed lines could be induced to connect to the service so as to secure a 100 per cent saturation, it would reflect itself in a reduced average investment per customer as well as reduced cost for the service.

The Bureau of the Census of the United States classifies the population of the nation into urban and rural. As shown in Table 1, 53,820,223 people, or 12,532,139 families, were classified as rural in 1930. Of the latter, 5,927,502, the non-farm group, live in farming communities and in towns of 2,500 and less, while an additional 6,604,637 families live on 6,288,648 farms.

Of the rural non-farm group 3,511,114 families, or 59.2 per cent, receive electric service. This information is based upon the count of domestic electric meters made by the electric division of the U. S. Bureau of Foreign and Domestic Commerce in 1930. It is asssumed that these data have not changed materially since they were collected, as the total number of residential customers of the United States has been more or less constant since 1930.

Of the farm group only 743,954, or 11.8 per cent, enjoy the advantages of electricity. Although the number of people living on farms exceeds that of the rural non-farm inhabitants by about 6,500,000, the ratio of the number of non-farm families to the number of farms receiving electric service is 4.7 to 1. In other words, the number of rural non-farm families receiving electric service is nearly five times as great as the number of farms that have it. It is interesting to note that the states of Maryland, South Dakota, North Dakota, West Virginia, and Idaho have from ten to twenty times as many rural non-farm homes electrified as farms. The states of Idaho and Utah range about one to one, and Washington two to one.

TABLE 1. ELECTRIFIED HOMES AND FARMS IN THE UNITED STATES

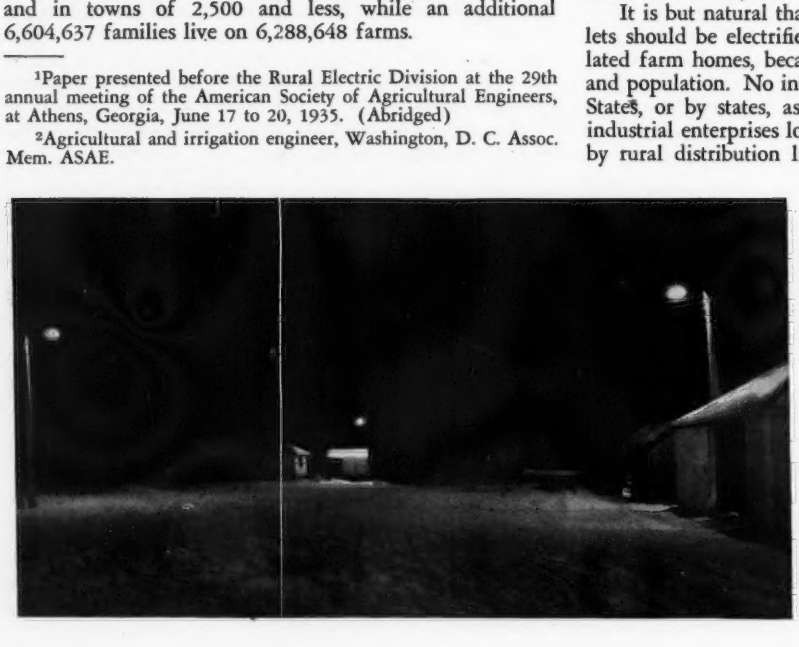
	Population, 1930 census	Total number of families (private homes)	Homes receiving electric service	Farms and rural non-farm homes not receiving electric service
Urban	68,954,823	17,372,524	15,962,168	
Farm	30,157,513	6,604,637[a]	743,954[b]	5,544,694[c]
Non-farm[d]	23,662,710	5,927,502	3,511,114	2,416,388
Totals	122,775,046	29,904,663	20,217,236	7,961,082

[a]Number of farms in the United States, 6,288,648
[b]Farms, December 31, 1934
[c]Farms
[d]Rural non-farm homes includes all villages and hamlets of 2,500 and less population.

It is but natural that the rural cities, villages, and hamlets should be electrified earlier than the more or less isolated farm homes, because of the greater density of homes and population. No information is available for the United States, or by states, as to the number of commercial and industrial enterprises located in rural areas which are served by rural distribution lines. Needless to say these do and will play an important part in the electrification of rural America.

There is a wide variation among the states in the per cent of rural non-farm homes receiving service. The New England states rank first in the nation with several of them exceeding 90 per cent. The southern states, as a whole, are the last, ranging from 25 per cent and up.

When the farms and rural non-farm homes receiving service are combined, only 35 per cent of the total have this advantage. Again the New England states with an



An electrically lighted farm yard

[1]Paper presented before the Rural Electric Division at the 29th annual meeting of the American Society of Agricultural Engineers, at Athens, Georgia, June 17 to 20, 1935. (Abridged)

[2]Agricultural and irrigation engineer, Washington, D. C. Assoc. Mem. ASAE.

average of 77 per cent electrified, the middle Atlantic states with 63 per cent and the Pacific states with 70 per cent rank among the first. The south central states with an average percentage of 11 and 14 for the east and west groups, respectively, are the lowest.

RURAL ELECTRIFICATION IN FIVE NEW YORK COUNTIES

Information pertaining to several specific areas may be helpful in developing a clearer picture of rural conditions as they actually exist. An exhaustive economic study of land utilization was made by Cornell University in Tompkins, Montgomery, Broome, Chemung, and Monroe Counties of New York. Factors such as the productivity of the land, ability to pay for electric service, proximity to markets, density of farms, condition of highways, and many other details were considered in the selection of the proposed distribution lines.

These five counties have a total of 1,270 miles of rural lines. A total of 13,687 buildings are adjacent to these lines, of which 11,046, or 80.7 per cent, are receiving service. The number of residences, camps, commercial establishments, schools, and churches is nearly twice the total of the farms, being 9,030 and 4,657, respectively. Of the farms 84 per cent, or 3,911, are receiving service, while of the non-farm buildings 79 per cent, or 7,135 are connected to the rural distribution lines. The average number of farms per mile is 3.7 and the number receiving service is 3.1. For the rural non-farm buildings, the average receiving service is 5.6 out of 7.1 per mile of line. The total density for all rural buildings is 10.8 per mile of line with 8.7 connected. Construction of an additional 1,258 miles of rural lines to serve 6,301 rural customers was recommended for these same five counties. This is at the rate of 5 per mile. If the per cent connected in the future should be the same as for the existing lines (80 per cent), the average number served will be reduced to 4 customers per mile. It is interesting to note that the number of farm customers per mile (3.6) is practically identical with those living adjacent to existing lines. The number of the other rural non-farm customers is, however, materially reduced, averaging only 1.4 per mile.

If the proposed rural lines are built in these five counties in New York, the average number of all farms per mile of line will be 3.6; all rural non-farms, 4.3; and the total of all rural customers, 7.9. If the same connection percentages are used as for the existing lines the total number of connected customers per mile of line will average 6.4 with 3.0 farms and 3.4 non-farms. The present average is 8.7. This survey will serve to illustrate that as a general rule the more densely settled rural areas have electric service. Indications are that rural lines constructed in the future will serve fewer customers per mile. This reduction will be primarily in the number of rural non-farm customers connected, while the number of farms served per mile of line will remain practically constant.

Another study in this same state, including Montgomery and Tompkins Counties and parts of the Counties of Seneca, Orange, and Ulster, showed 79 per cent of all possible customers living adjacent to rural distribution lines connected and using service. The per cent connected per county ranged from 56.5, the lowest, to 89.5, the highest.

PROGRESS IN RURAL ELECTRIFICATION IN PENNSYLVANIA

An analysis was also made of the kind, type, and per cent of the various groups of customers connected. The results were as follows:

This picture shows typical uses for electric power in the farm home. Building up the electrical load reduces the physical load

1 Farms at least 50 per cent above the average in size and volume of business, 99 per cent connected
2 Farms average or above, but below Group 1, 90 per cent connected
3 Farms below average, but likely to remain in agriculture, 78 per cent connected
4 Submarginal farms, 45 per cent connected
5 Rural residences, average or better, 80 per cent connected
6 Rural residences, below average, 47 per cent connected
7 Commercial service, including churches and schools, 82 per cent connected.

Since 1927 statistics have been gathered annually as to the number of farm and non-farm customers on rural line extensions in Pennsylvania. These statistics were compiled from the Pennsylvania triennial census of 1927, the federal census of 1930, and reports of the electric utilities. In compiling these data the federal census definition of a farm was followed.

By the end of 1934, 179,078 rural customers were connected to rural distribution lines. Of this number 133,704 were rural non-farm customers and the balance 45,374 farms. The growth since 1927 has been continuous for both of these classes. In recent years, however, there has been a decline in the rate of growth. The ratio has remained constant at one farm to every 2.9 rural non-farm customers connected.

At the end of the year 1933, Pennsylvania had a total of 13,458 miles of rural distribution line, with an average of 13 connected rural customers per mile. This is a high average customer density for rural lines.

A more detailed study in 1932, of 3,000 miles of line serving 22,733 customers, revealed 6,348 premises which were not taking service. This is 27.9 per cent of the properties along the route of these lines. This analysis did

not subdivide the potential customers as to farm or non-farm. The density on these lines is approximately 7.5 customers per mile. If the potential customers living adjacent to these existing lines should be connected at some future date, resulting in a 100 per cent saturation, it would increase the density another 2.1 customers per mile, making a total of 9.6.

VIRGINIA ELECTRIC AND POWER COMPANY RURAL ELECTRIFICATION REPORT

A study of the density of electrified farm and rural non-farm customers per mile served by the Virginia Electric and Power Company, reveals some very interesting facts. This company has been active in the construction of rural lines and the connection of customers to these lines since 1929. During this period the number of miles of line built nearly doubled, being 802 in 1929 and 1,580 in 1933. This is also true of the total number of farms connected, these being 953 in 1929 and 1,765 in 1933. Again, as in New York state, the average of all farm customers per mile has remained rather constant at about 1.1.

In 1929 these same rural lines served a total of 6,379 rural non-farm customers. The number connected increased to 10,576 in 1933. The average for this group was 8 per mile in 1929 and has decreased to 6.7 in 1933. The average for all rural customers per mile has also decreased during this period, which was 9.1 in 1929, and 7.8 in 1933.

The ratio of farm to non-farm customers for this same company is 1 to 6. The increase in the number of farm customers connected has been more rapid in recent years than the rural non-farms, resulting in a drop of the ratio of nearly 1 to 7 in 1930, to 1 to 6 in 1933.

BUILDING THE LOAD ON THE FARM

Another phase of rural electrification that warrants consideration and study is the method employed to increase the energy consumption on the farm, and at the same time making it profitable to the user. There are more than 250 different electric applications suited to operation on the farm including the farm home. The selection, purchase, and use of electric equipment on farms is limited in many cases to those items which will return a profit to the operator. This does not necessarily mean an increase in the cash income, but decreased expenses because of the ability to accomplish more per individual per day through their aid. The use of electric motors and appliances lends itself readily to automatic operation and so enables the operator to save a maximum of time and labor. In a large measure the reasons for using electricity on farms are to increase the income or reduce the operating expenses. If this is not accomplished, the cost of the electric service may become a burden to some farms because of their limited income. Unless a reasonable number of appliances, especially adapted to the work to be performed, are used, the greatest benefits to all of the members of the family cannot be derived from the electric service.

Two of the major deterrents to the use of electric equipment are the initial cost of the appliance and the cost of operation reflected in the cost per kilowatt-hour. It is not only necessary that the investment in the equipment be low, but it should also be sturdily constructed so as to have a long life. Both of these are important, if they are to be purchased and used on the largest number of electrified farms rather than only on an occasional one. Sturdy construction is essential as it means a minimum loss of time because of equipment being out of order, reduced repair bills, and low depreciation. A low purchasing price for the equipment results in a lower annual fixed cost, including such items as interest, taxes, and insurance.

In the event that a rural customer has a large number of appliances, it is essential that the rate for energy be low enough to make it profitable to use them. High rates for energy retard the use of equipment because of high bills which have to be paid monthly and the competition offered through other sources of light, heat, and power.

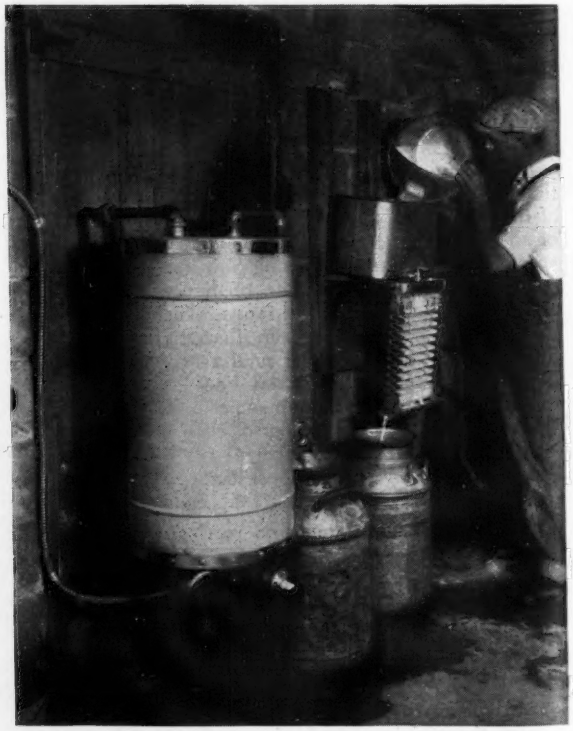
Agricultural engineers of fifteen of the state agricultural colleges (California, Idaho, Iowa, Kansas, Maryland, Massachusetts, Michigan, Missouri, Nebraska, New Hampshire, North Carolina, Pennsylvania, South Dakota, Texas and Virginia) estimate that eventually the average energy consumption including all types of farms will be about 5,000 kilowatt-hours per farm per year. The future average annual consumption as reported for the various types of farm are: General, 2,900 kilowatt-hours; cash grain, 2,800; fruit, 5,000; truck, 3,800; dairy, 7,500, and poultry, 4,200. They further estimate that the average farm of the future, outside of irrigated areas, will have a connected load of 25 kilowatts.

THE GROWTH OF ENERGY CONSUMPTION ON FARMS

Exceptional progress has been made by numerous electric utilities in developing the use of electric equipment on the farms in the territory in which they operate. One of these bases its success in promoting the use of electric equipment on farms upon the following program of activities:

1 College-trained agricultural engineers who have a practical farming background, are employed by the company. These men work with all existing agricultural agencies for the purpose of formulating and putting into practice a broad rural electrification program. These men do not sell any electric equipment, but render service of a personal nature.

2 The company installs in *(Continued on page 450)*



This picture shows a farm dairy equipped with electric water heater and milk cooler

Results of House Heating Studies[1]

By Arthur H. Senner[2]

THE IMPORTANCE of heating to winter comfort, health, and the general standard of living on the farm is obvious to practically everyone. The Division of Structures of the Bureau of Agricultural Engineering (USDA) has for several years attempted to keep abreast of the problem of house heating, with special reference to the demands of the farm home.

While it is no doubt true that about 50 per cent of the homes of the country are still using stoves and kitchen ranges for heating, it is also a fact that there is an ever-increasing interest in the so-called central type of heating system.

Our studies dealing with home-heating problems have been guided largely by the desire to obtain answers to the many typical inquiries which we receive from day to day. Thus we have issued at one time and another publications dealing with one-pipe furnaces, the operation of home heating plants, the domestic oil burner, the so-called distillate oil burner for kitchen ranges and water heaters, the construction of chimneys and fireplaces and so forth. The importance of some of this work can be illustrated by reference to the project on the domestic oil burner, which has produced two publications. The Bureau got into this problem at almost the beginning of the use of domestic oil burners. The original experimental work was conducted at the Arlington Experiment Farm. The technical publication presenting basis data largely of interest to the designer and oil-burner technician was soon exhausted. The non-technical publication, which was written to meet the demand of prospective purchasers of domestic oil burners for information on this type of heating equipment, was also widely distributed and today we are receiving more calls for it than ever before.

Our experimental work has been continued by popular demand, so to speak, of the public and the manufacturers, and within the past few days we have concluded the experiments of a major project on domestic oil burners and associated specialties at the John Hopkins School of Engineering, which institution has cooperated enthusiastically in this as in some of our other work. It was the object of this last series of tests to obtain the information necessary to answer the many and increasingly-varied inquiries on the subject. We plan to make the results of our studies available in technical and non-technical publications.

Certain fundamental scientific facts have been uncovered as a result of the domestic oil burner work. For example, the nature of the combustion of oil fuel and the analysis of the products of combustion have been studied minutely. In this connection, we all recall, no doubt, the familiar engineering flue-gas analysis by which we determined the make-up of the products of combustion in connection with tests of boilers. We found early in our studies that the products of combustion resulting from burning oil in small boilers were not so simple that they could be analyzed in this manner.

In figuring heat balances, with data obtained by the ordinary engineering Orsat, high unaccounted-for losses amounting to perhaps as much as 15 or 20 per cent of the fuel were disclosed. This indicated that there is some fuel which is unconsumed but which is not detected by the ordinary flue-gas analyzer. This unaccounted-for fuel could not be entirely in the form of soot without being readily noticeable, yet even with a comparatively clear stack this loss was always present to a degree. In some instances of oil-burner tests, particularly in the case of large industrial boilers, losses up to several per cent have been attributed to soot formation. Even when this loss was comparatively great, the ordinary Orsat apparatus seldom gave any indications of CO. When presence of CO was detected at all, the amount was only a trace, and this would account for only a small portion of the losses. The assumption has sometimes been made that radiation might account for a large percentage of this lost heat. However, when the boiler is used merely as a low-temperature calorimeter and relatively cool water is passed through it, thus rendering the radiation small, this unaccounted-for loss still persists. For a more complete heat balance we substituted a different technique —the flue gases were analyzed by means of the so-called Bureau of Mines type of Burrell Orsat whereby H_2, unsaturated by hydrocarbons, and saturated hydrocarbons could be determined in addition to the compounds indicated by the ordinary Orsat apparatus.

This perhaps seems somewhat like a diversion from the general problem of heating, but I have cited this detail because it was one of the phases of our study which enabled us to work more intelligently on the problem of improving the cleanliness and efficiency of burning oil in small boilers. Incidentally, our requirements for the detection of small quantities of H_2 in the flue gases stimulated one of our laboratory assistants to discover a liquid reagent which does the job conveniently.

Another type of oil burner of special interest to the farmer is the so-called distillate burner, or, as it is frequently termed, the range burner. It differs from the ordinary house heating oil burner in that it must use lighter oil as fuel, and it does not require a motor, a blower, or an oil pump for its operation. On the other hand, it differs from the wick type of oil stove in the way the fuel is vaporized, and in its larger heating capacity. It has been called the range oil burner because of its relatively extensive use in kitchen ranges.

Uses of the distillate oil burner range from the heating of small garages to the heating of complete homes of moderate size. As to the fuel which the distillate burner can handle satisfactorily, the oil should be of a type that can be easily vaporized and will leave a minimum of carbon in the vaporizing grooves and on the kindlers and other burner parts. The three fuels which have been recommended for distillate burners by the manufacturers are kerosene, a special so-called range burner oil, and No. 1 domestic fuel oil. No. 1 domestic fuel oil is the lightest of the grades that are ordinarily supplied for the power-type oil burners.

Because the Bureau has done considerable work on oil fuels, please do not infer that we have not given thought to the burning of solid fuels. Farmers' Bulletin No. 1698, entitled "Heating the Farm Home," deals with the general requirements that should be met by a home heating system, sets forth the characteristics of different types of such systems, and gives advice on selecting heating

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[1]Paper presented before the Farm Structures Division at the 29th annual meeting of the American Society of Agricultural Engineers, at Athens, Georgia, June 17 to 20, 1935.

[2]Associate mechanical engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. Mem. ASAE.

plants for farm homes and on ways of conserving fuel. Rules for burning large-size anthracite, or buckwheat, for burning coke or wood with anthracite pea or buckwheat, and for burning bituminous coal are presented. There is also some discussion of temperature regulators, and a section dealing with ways of conserving heat.

The cost of heating a house depends principally upon

1 The average outside temperature and the exposure of the house to winds
2 The degree of weather tightness of the house
3 The average temperature maintained inside the house
4 The efficiency with which the fuel is burned and the heat transmitted to the several rooms
5 The unit cost of the fuel.

Now it is clear that there are some factors about which nothing can be done in the way of saving fuel in heating a house which is already built. Specifically, the outside temperature cannot be altered, nor can the exposure of the house to winds be changed very readily. Fortunately, however, there are several factors about which something can be done. In the matter of the weather tightness lies an opportunity for savings in many homes. If a house is to be heated properly and economically, it must be tightly constructed. Heat is lost through walls, roof, and windows, and through openings and cracks. Most houses can be made more comfortable at small cost by applying weather-stripping or insulation or by correcting construction defects.

In those sections of the country where the winters are severe, double sash, or storm sash as it is frequently called, greatly reduces the leakage of air and also lessens the loss of heat through the windows. Storm doors also are helpful. Screen doors covered with building paper are very effective in increasing comfort and in saving fuel. Wood-and-felt weather-stripping, or even the cheap felt strips or strips from old rubber inner tubes properly installed aids in keeping out cold air. Metal weather-stripping is efficient in reducing leakage around windows and aids in making a house weather-tight. Tight thresholds under bedroom doors prevent cold drafts into other rooms when the bedroom windows are open.

The average temperature maintained in the house effects the fuel bill. When we say that fuel can be saved by maintaining a lower average temperature in the house, the question probably will be asked immediately, What about the health? What is the good of saving ten or fifteen dollars a year in fuel if as much or more is expended in doctor's fees for children or grown-ups who contract illnesses due to lowered temperatures? We do not recommend abnormally low temperatures in the rooms generally occupied during the day, but rather a judicious heating of only those parts of the house that are habitually occupied by the housewife or by children playing indoors. While this practice is followed to a considerable extent, in some sections probably more than among urban dwellers, it seems appropriate to mention that appreciable savings can be made by such methods as heating only the first floor of a dwelling and shutting off the upper floors by doors already available or which perhaps can be installed at comparatively small cost. Sometimes portieres can be used effectively to shut off certain rooms.

Another factor to be considered is the efficiency with which the fuel is burned and the heat distributed to the several rooms. At first thought, it might be concluded that this depends principally upon the original selection of the equipment and the method of installation. That is true to a considerable degree, yet there is much that the householder can do to obtain heating efficiency.

The relative costs of heating and cooking with several important types of fuels are presented in our circular on the distillate burner. Relative merits of the several types of heating systems—such as hot water, steam, vapor, and hot-air are discussed somewhat in the general bulletin on heating the farm home. In order to permit the prospective purchaser to estimate the relative expenditures necessary to secure the different types of systems, a table is presented giving the relative costs of the several types. I might say at this point that the collateral job of planning the hot-water supply for the rural home can be simplified by the aid of Farmer's Bulletin 1426 on farm plumbing.

I have referred to the work which we have been doing at the John Hopkins School of Engineering on recent developments in the domestic oil burner field. It might be of interest to know of some of the projects planned for the near future by the Bureau's division of structures. One of these deals with the coal-burning and wood-burning kitchen ranges used to such a great extent in this country.

Some work along this line already has been begun by the Anthracite Institute Laboratories. Recently I saw some interesting stoves under test at that laboratory. One was a stove that combines complete house-heating possibilities with the usual cooking feature of the ordinary stove. In general external appearance it is not unlike the conventional stove, but it is somewhat larger. In this stove, which is designed primarily for burning anthracite, the heating of the house is accomplished by warm air forced by a fan through ducts from the heater to the several rooms. The same fan is used to provide forced draft to aid combustion. Because of the forced draft, the combustion rate or amount of coal burned per square foot of grate area is high, which permits a relatively large job of heating to be done with a rather small grate. The cooking feature of the stove is about the same as the ordinary range. The serious objection to the ordinary kitchen range in the summer time—the fact that the kitchen becomes overheated while cooking—exists with this stove also. It seems, however, that there are considerable possibilities in this type of unit if the price can be reduced.

Rural Electrification in the United States

(Continued from page 448)

rural homes, at its own expense, all necessary wiring for ranges and water heaters. This practice has resulted in a substantial increase in connected load.

3 A deferred payment plan extending over a period of 24 months has been established to increase the use of major appliances in rural homes.

4 Rural rates have been constantly lowered and promotional rates applicable to rural homes using major appliances have been introduced.

As reported, this plan or policy of developing the rural electrification business went into effect in 1929. By the end of 1933, 905 additional farm customers, or an increase of 105 per cent over the number previously served, were connected to rural distribution lines. During this same time the average yearly consumption per farm customer increased from 1,001 in 1929 to 2,065 kilowatt-hours in 1933, or 106 per cent.

Because of the average increased consumption per farm and the reduction of rates by the company, it is reported that the average cost per kilowatt-hour dropped from 6.6 cents in 1929 to 3.8 cents in 1933. Even with an increase of more than 100 per cent in the average annual energy consumption per farm, the average annual bill per farm customer increased only from $66.39 to $79.13, or $12.74.

Equilibrium Moistures of Some Hays[1]

By Frank. J. Zink[2]

INVESTIGATORS of either artificial drying or field drying of forage hays have been handicapped by the lack of basic information relating to the physical properties of such materials. There are no available data which indicate what will be the end point or final moisture content of hay which may be approached when drying with air of some specific humidity condition. It is commonly known that alfalfa may be cured in less than a day in some sections of the country, while in others as long as two weeks are required. Also, in certain regions of the world it is impossible to cure with any but special methods of handling. Further, considerable variation exists in air-dry moisture content of alfalfa as observed at Manhattan, Kansas, alfalfa 7.4 per cent (4)[3]; Lincoln, Nebraska, 11.4 per cent (2); Chico, California, 11.7 per cent (5); and St. Paul, Minnesota, 16.0 per cent (1). This latter was the condition in January.

Also, it is commonly known that humidity is one of the factors accounting for the great difference of time required for drying and for the variation of air-dry moisture content. Other factors known to have some influence on the rate of curing are air temperature, wind movement, and ground moisture, as well as characteristic differences of plants.

It is obvious that before real progress can be made on either natural or artificial drying, some basic information must be made available. Of the above factors, atmospheric humidity is of prime importance and perhaps one of the most troublesome. Not only does atmospheric humidity have an important place in rate of drying and final moisture content approachable, but it is thought that the relative humidity of the air may be an important factor relating to quality of the final product. It is well known that low humidities have a tendency to produce what is termed "case hardening" in certain industries. This may be related to stem pliability and brittleness of hays, one of the factors of market-hay grading. It may also relate to leaf shattering due to brittleness rather than to moisture content.

Most materials are hygroscopic; that is, they are continually undergoing change in moisture content, either losing moisture to or picking up moisture from the surrounding atmosphere. An obvious question is, therefore, what is the equilibrium moisture content of a hay when in a certain environment, supposing that the relative humidity of the atmosphere remained unchanged sufficiently long for a material to reach its hygroscopic equilibrium? By having this information for any specific hay, it would be possible to study temperature and rate of air movement as factors of drying. With such data the prediction of final moisture content is possible, and hay shrinkage, moisture regain, and air-dry moisture variations are explained in part.

Hygroscopic moisture is defined by Lindsay (3) as "the moisture contained in a hygroscopic material in equilibrium with relative humidity of surrounding atmosphere." He also states that moisture content depends upon relative humidity of atmosphere but varies widely with different materials. Other terms have been applied to this phenomenon which include hygroscopic, equilibrium, and regain moisture. The term "equilibrium" appears to be most expressive and is therefore used in this study.

A review of the literature on this subject does not reveal any data for hay. Some few data on grains are reported, and considerable information is available on equilibrium moistures of both organic and inorganic industrial materials. Some materials, such as paper and textiles, have been closely studied, and the industries dealing with these materials are dependent on the maintenance of constant atmospheric moisture for best conditions of processing. Methods of making this determination therefore are available and the method used in this research is similar to that suggested by Wilson (6). This method consists of controlling the humidity by sulphuric acid solutions in desiccators. The acid density, temperature, and humidity relationships were used as worked out by Wilson. The method as used was changed, and instead of having still air within the desiccators, the air was kept in motion. This was done by means of small fans mounted on pivots inside the desiccators. The fans were induced to rotate by a series of mechanically-driven permanent magnets passing outside the desiccators. This method of moving air is shown in the accompanying illustration. Fifteen desiccators were used, ranging for control from 0 to 100 per cent relative humidity. They differed by approximate increments of 7 per cent relative humidity.

The samples were finely divided and approximately 7 grams each were used. Aluminum moisture dishes fitted with covers were the receptacles used, the covers being in place only when weighing. The samples were weighed periodically until equilibrium was reached as indicated by no further change in weight. The moisture of the original sample was obtained to the nearest 0.01 per cent by careful analysis, and final moisture content was calculated from the original moisture and the initial and final weights of each of the 15 samples. Weights were taken to the nearest milligram with an analytical balance. The specific gravity of the acid was measured at the end of the experiment, and its condition at that time was used for determining the existing relative humidity. The temperature was regulated electrically and held nearly constant somewhat above room temperature.

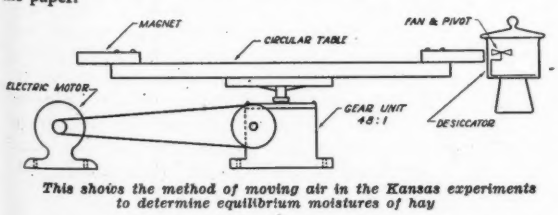
The results obtained are shown in Table 1. It should be pointed out that in the high humidities, especially above 85 per cent relative, the approach to equilibrium was frequently interferred with by mold development. The moistures reported in the range above 85 per cent relative humidity are on the basis of maximum attained before mold growth resulted in weight losses. This usually took place 2 to 4 days after the first visible appearance of the mold.

The rate of gain or loss of moisture by the samples could not be used as a measure of drying rate or regain rate because it is not known just what rate moisture will diffuse from or be absorbed by the acid solution. At least one investigator has made the error of using this absorp-

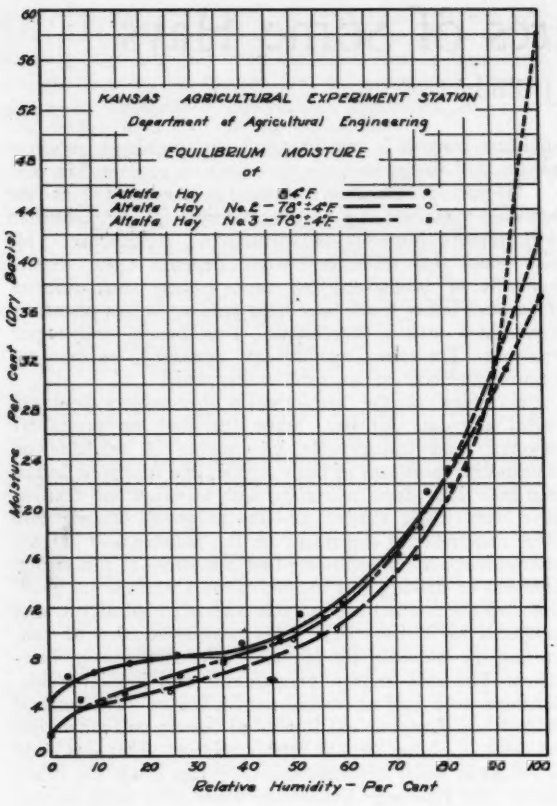
[1]Contribution No. 67 of the department of agricultural engineering, Kansas Agricultural Experiment Station.

[2]Associate professor of agricultural engineering, Kansas State College.

[3]Numbers in parentheses refer to literature cited at the close of the paper.



This shows the method of moving air in the Kansas experiments to determine equilibrium moistures of hay



tion rate of the acid as a measure of the drying rate.

It is thought that a quick means of measuring moisture may be suggested by these data. It is readily seen that moisture content is a function of humidity. Therefore, it should be possible to measure the relative humidity of the enmeshed air, and, by reference to an equilibrium curve of the material involved, establish the moisture content with reasonable accuracy. Such a rapid means of measuring moisture would be very helpful to research work on hay curing.

TABLE 1. EQUILIBRIUM MOISTURES OF SOME HAYS

Material	Moisture content at various relative humidities (Per cent dry basis) 10	20	30	40	50	60	70	80
Alfalfa (1)	7.0	8.0	8.5	9.5	11.0	13.0	16.0	21.0
Alfalfa (2)	4.0	5.0	6.0	7.0	9.0	11.0	15.0	17.0
Alfalfa (3)	4.0	6.0	7.0	8.0	10.0	12.5	16.5	19.0
Prairie hay	6.0	6.5	7.5	8.5	9.5	11.0	12.0	14.5
Red Clover, U. S. No. 1 (extra green)	6.0	7.5	8.2	9.2	10.5	12.5	15.5	20.0
Red Clover U. S. No. 2 (brown)	6.3	7.3	8.0	9.0	10.2	12.5	15.5	20.5
Oat straw (threshed)	5.0	6.0	7.2	8.2	9.3	11.0	13.0	17.0

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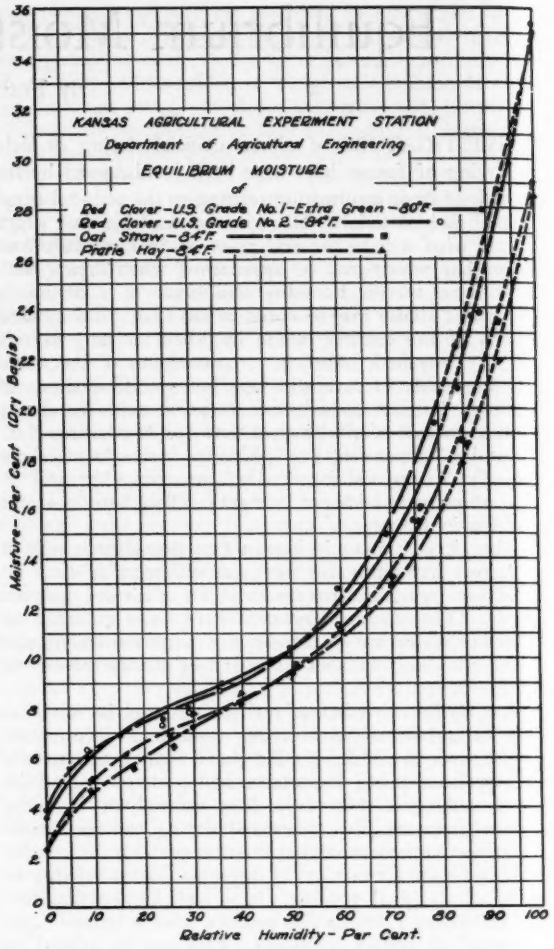
4 Salmon, S. C., Swanson, C. O., and McCampbell, C. W. Experiments Relating to the Time of Cutting Alfalfa. Kansas Agricultural Experiment Station Tech. Bul. 15. 1925.


KANSAS AGRICULTURAL EXPERIMENT STATION
Department of Agricultural Engineering
EQUILIBRIUM MOISTURE
of
Red Clover - U.S. Grade No.1 - Extra Green - 80°F
Red Clover - U.S. Grade No.2 - 84°F
Oat Straw - 84°F
Prairie Hay - 84°F
Moisture - Per Cent (Dry Basis)
Relative Humidity - Per Cent.

5 Vinall, H. N. and Roland McKee. Moisture Content and Shrinkage of Forage and the Relation of these Factors to the Accuracy of Experimental Data. USDA Bul. 353, Bureau of Plant Industry. 1916.

6 Wilson, R. E. Humidity Control by Means of Sulphuric Acid Solutions. Journal of Industrial and Engineering Chemistry. 13: 326-31. 1921.

How Explosives Act

OF PARAMOUNT importance in blasting of any sort is the proper confining of the explosive used so that none of its force will be wasted. The logic of this is at once apparent when it is realized that, when an explosive is detonated, a solid is converted into another form, largely gaseous, and pressure is exerted equally in all directions. This pressure, however, follows the line of least resistance. If, therefore, a bore hole is not properly tamped, there is certain to be a very considerable loss of pressure, due to the escape of the gases generated by the detonation of the explosive. A charge of explosive, loaded in earth, blows out a right-angled inverted cone. The deeper the charge is placed in the ground, the greater will be the area of the base of the cone. That means that a greater quantity and weight of material is removed, requiring a correspondingly greater quantity of explosive. The point is that too deep loading results in a waste of explosives and also makes too large a crater.

L. F. LIVINGSTON

NEWS

Meeting Programs of ASAE Technical Divisions

FOUR technical divisions of the American Society of Agricultural Engineers have arranged programs for meetings to be held at the Stevens Hotel, Chicago, December 2 to 5. The principal features of these programs are presented here:

POWER AND MACHINERY DIVISION PROGRAM

The Power and Machinery Division will hold its meeting December 2, 3, and 4. The forenoon program of Monday, December 2, will include two papers: "Measuring the Forces on Soil Tillage Tools," by A. W. Clyde of Pennsylvania State College, and "Patent Policies and Procedure," by G. D. Jones of the Cleveland Tractor Company. These papers will be supplemented by prepared discussions and informal general discussions from the floor.

The afternoon program will feature three talks under the general title "Farm Machinery Developments Observed in Europe," by G. W. McCuen, Ohio State University; J. B. Davidson, Iowa State College; and E. R. Gross, New Jersey State College of Agriculture, all three of whom have recently visited important centers of agricultural engineering interest in Europe, while in attendance at the Second International Congress of Rural Engineering at Madrid.

Monday evening is being reserved for committee and other group round tables, which will be arranged especially for groups interested in conducting such round tables.

The forenoon session of Tuesday, December 3, will include three papers as follows: "Soil Wear Test of Plow and Tillage Implement Steels," by J. Roberts, Kansas State College; "New Developments in Insect Pest and Plant Disease Control," by R. M. Merrill, USDA Bureau of Agricultural Engineering; "Performance Studies of Small Grain Combines," by W. M. Hurst, USDA Bureau of Agricultural Engineering.

The afternoon program will be jointly sponsored by the Power and Machinery Division and the Rural Electric Division. It will open with an address by W. C. MacFarlane, president of the Farm Equipment Institute, who will have many things of timely interest to discuss with agricultural engineers. The remainder of the session will be featured by a paper on feed processing in relation to animal nutrition by Professor G. Bohstedt of the University of Wisconsin, and by a paper on results of studies of buhr mill design and performance by H. D. Bruhn, agricultural engineer, of the same institution.

For the forenoon of Wednesday, December 4, the Power and Machinery Division will join with the Soil and Water Conservation Division in presenting a program which will be devoted largely to a symposium on "Terracing Equipment and Terrace Construction Practice," which will be led by R. W. Baird, of the USDA Soil Conservation Service, in which he will discuss this subject as particularly applied to the Oklahoma and Texas area. This will be followed by prepared discussions by four agricultural engineers as applied to the Pacific northwest, the western wheat belt, the corn belt, and the Piedmont areas. In addition to this there will be two short papers, one on new developments in harvesting native grass seed by G. C. Fuller, assistant agronomist of the USDA Soil Conservation Service, and the results of recent work in developing sodding equipment and contour furrowing by C. A. Logan of the SCS.

FARM STRUCTURES DIVISION PROGRAM

The Farm Structures Division will hold its meeting December 2 and 3. The forenoon session of Monday, December 2, will be devoted to a round table on safe storage of grain under seal on the farm, which will be led by Wallace Ashby, chief, division of structures, USDA Bureau of Agricultural Engineering, and a representative of the Bureau of Agricultural Economics, and will be followed by a series of prepared discussions and informal discussions from the floor.

The afternoon session of the same day will be devoted to a symposium on the general title "New Applications of Materials in Farm Building Construction." The feature of this part of the program will be a presentation and discussion of the more recent developments in concrete, lumber, steel, and other products used in farm building construction.

The evening of the same day will be devoted to a round table on the cooperative farm building plan services, in which the Structures Division has played such an important part.

The forenoon program of Tuesday, December 3, will be sponsored jointly by the Farm Structures Division and the Rural Electric Division. It will open with a report on new rulings affecting rural fire insurance premium rates by Harry E. Roethe of the USDA Bureau of Chemistry and Soils. In addition there will be a paper on farm structures planned for electric wiring and equipment installations by H. B. White, University of Minnesota, and a paper on new developments in farm wiring by J. D. Noyes, Detroit Edison Co.

The afternoon program will feature a paper on the subject "Beauty and Economy in Farm Homes," by Henry K. Holsman, a Chicago architect who designed "The Country Home" model farmhouse at the Worlds' Fair. Supplementing Mr. Holsman's paper a number of agricultural engineers who have made intensive study of farmhouse design will present prepared discussions of a variety of phases of this general subject.

RURAL ELECTRIC DIVISION PROGRAM

The Rural Electric Division will hold its meeting December 3 and 4, and as indicated above the forenoon program for December 3 will be a joint one with the Farm Structures Division and the afternoon program will be held jointly with the Power and Machinery Division.

An evening session of the same day will feature three papers as follows: "Line Construction Costs and Specifications," by Arthur Huntington, Iowa Electric Light and Power Company; "Line Extension Policies," by J. H. Gallagher, Michigan State College, and "Rural Load Building," by W. J. Parvis, rural service engineer, Public Service Company of Indiana.

The forenoon session of Wednesday, December 4, will feature a number of brief reports on the more recent developments in the general field of rural electrification. This will include a report on ultra-violet light in dairy production by L. C. Porter, General Electric Co.; irrigation in humid areas by Richard Boonstra, Public Service Corporation of Northern Illinois; electric equipment in poultry production by T. E. Hienton of Purdue University; soil heating and soil sterilization by M. W. Nixon of the Empire State Gas and Electric Association, and a report on the electric fence.

On the program for the afternoon session, the Rural Electrification Administration at Washington has been invited to furnish a speaker to tell about its program of activity. In addition there will be a paper on light and its effect on plant growth by R. B. Withrow of Purdue University, and one on recent developments in new crop growing methods with electricity by Dr. E. A. White, director of the Committee on the Relation of Electricity to Agriculture.

SOIL AND WATER CONSERVATION DIVISION PROGRAM

The Soil and Water Conservation Division will hold its meeting December 4 and 5, and as indicated above the program for the first session, on the forenoon of Wednesday, December 4, will be a joint program with the Power and Machinery Division.

On the afternoon session of the same day will be three papers as follows: "Program of Work for CCC Drainage Camps," by Lewis A. Jones, USDA Bureau of Agricultural Engineering; "Results of Rainfall Intensity-Frequency Studies," by D. L. Yarnell, USDA Bureau of Agricultural Engineering, and "Possibilities in Rural Resettlement in Wisconsin," by W. A. Rowlands, assistant state leader of county agents for Wisconsin.

The entire program for Thursday, December 5, will be a symposium reviewing progress in the engineering phases of soil erosion control, and will consist of progress reports of the several subcommittees of the ASAE Committee on Soil Erosion Control, which include terrace project planning, erosion control in terraced outlets, control of gulley erosion, development of farm ponds as an erosion control measure, and development of lakes in rural communities for soil and water conservation.

A particular feature of the program for this day will be an address at the opening of the afternoon session on "What America's Soil Conservation Program Requires of the Engineer," by F. A. Fisher, a regional director of the USDA Soil Conservation Service.

* * * *

Further information in regard to these programs or other arrangements for these meetings may be obtained direct from the secretary of the Society at its headquarters in St. Joseph, Michigan.

Agricultural Engineers Dedicate Monument to Tile Drainage Pioneer

AN OUTSTANDING feature of the yearly meeting of the North Atlantic Section of the American Society of Agricultural Engineers held at Cornell University, Ithaca, N. Y., October 7, 8, and 9, was the dedication of a monument to commemorate the one hundredth anniversary of the first laying of drain tile in the United States.

In the September number of AGRICULTURAL ENGINEERING, B. B. Robb and J. R. Haswell describe the work of John Johnston, who in 1835 laid the first drain tile in this country. To commemorate this highly significant event in the history of American agriculture, a monument has been erected in a corner of the old Johnston farm and within sight of the old Johnston farmstead. The monument is located at the fork of two state highways a few miles east of Geneva and overlooking Seneca Lake.

The monument consists of a 14,000-pound boulder which was donated by Mr. E. R. Greener of Trumansburg, N. Y. Incidentally, the moving and placing of this boulder was an engineering feat of no mean proportions, and for which members of the agricultural engineering staff at Cornell deserve special credit. Mounted on this huge boulder is the bronze memorial tablet shown in the accompanying illustration.

The dedication services, which were held on the afternoon of Wednesday, October 9, were presided over by Dr. C. E. Ladd, dean of the New York State College of Agriculture at Cornell University. Dr. U. P. Hedrick, director of the Geneva Agricultural Experiment Station, extended greetings to those in attendance. L. F. Livingston, president of the American Society of Agricultural Engineers, and speaking for agricultural engineers as a group, emphasized the particular interest of the engineers in the pioneer work of John Johnston in originating tile underdrainage in America, and expressed the pleasure of the Society in the opportunity offered to honor this great American pioneer. Dr. A. C. Flick, state historian for New York, gave an interesting account of the history of the section in which John Johnston lived and worked. The U. S. Department of Agriculture was represented by S. H. McCrory, chief of the Bureau of Agricultural Engineering, who compared the significance of the laying of the first drain tile by John Johnston with the subsequent development of tile drainage in America. Dr. Liberty Hyde Bailey, professor and dean emeritus of agriculture of New York State College of Agriculture at Cornell, paid a high tribute to John Johnston for his pioneer work in tile drainage and for his outstanding contribution to improved agriculture, and closed his remarks with the reading of an appropriate poem from his book "Wind and Weather," entitled, "Tile Drain."

Far under the ground
As men pass by
Unseen and alone
I silently lie.

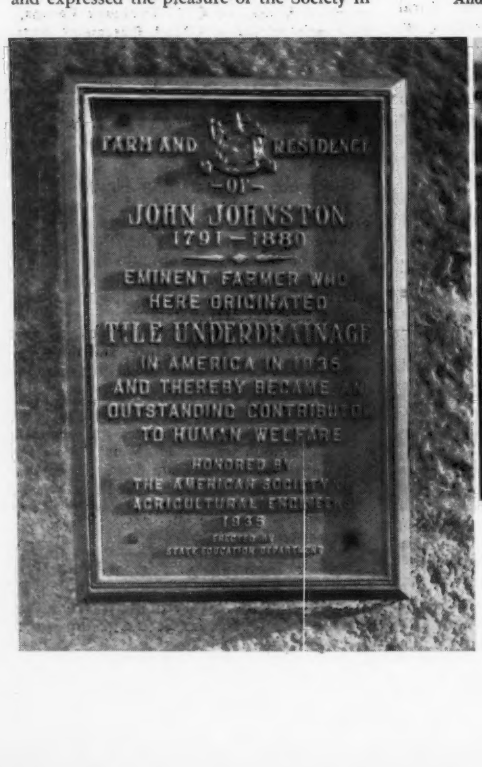
Under bottoms of springs
And under the pools,
'Neath slopes of long fields
And under old stools
Of bush and of brier,
'Neath roots of the grass
On hardlands and swale,
I straightforwardly pass.
I feel the cool earth
And slow trickling streams,
And roots of big trees
That pry in my seams;
And crawling things find
When pursued by alarms
A genial retreat
As they hide in my arms.
The soft summer showers
And long winter rains,
The springtime that floods
And the autumn that wanes,
The tempests that rend
With their sudden affright,
They disquiet me not
In the day or the night.
Far down to the bank
Of the streamlet I run
And carry my freight
To the drift and the sun;
And oft to my mouth
Do the yellow-birds come
And drink to their fill
When the stream is dumb.
The cattle I hear
As they move on the land,
And the burrowing folk
That build in the sand.
When the plow-team tramps
On the full crunching earth
I feel the hard thrusts
Of the first harvest birth;
But the plowman thinks not
That I lie down below
And tireless prepare
For the harvests to grow.
And as seasons return
All the pastures above
Respond to a touch
That he knows not of.

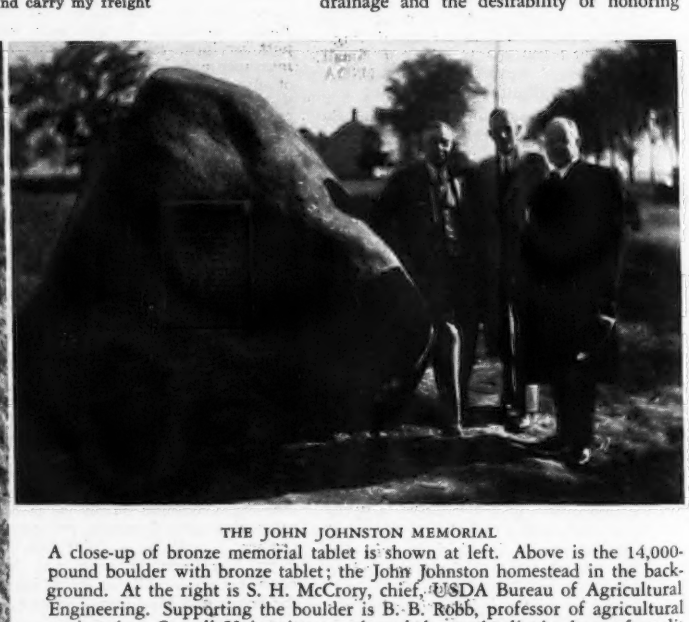
Years in and years on
I rest in my bed
And draw down the rains
When the farmer is dead;
And nothing I care
That the people know not
Whether I am
Or where is my lot.
All secrets I hold
Of the dead and the live,
For they all come at last
To the soil where I strive.

Calm and content
I silently lie
And carry my work
As men pass by.

The dedication ceremony was attended by approximately one hundred and fifty people, including the agricultural engineers who had been attending the ASAE North Atlantic Section meeting at Ithaca, and by a large group of descendants of John Johnston and farmers and others of prominence in the community. Following the dedication a reception and tea were given at the home of Mrs. Agnes Johnston Hutchins in Geneva. Mrs. Hutchins is a granddaughter of John Johnston, and during the reception at her home read a most interesting paper of reminiscences of her grandfather.

For several years the authors of the two articles referred to in the September number of this journal—B. B. Robb and J. R. Haswell—both members of ASAE, have directed attention to the great significance of the early work of John Johnston in tile drainage and the desirability of honoring





THE JOHN JOHNSTON MEMORIAL

A close-up of bronze memorial tablet is shown at left. Above is the 14,000-pound boulder with bronze tablet; the John Johnston homestead in the background. At the right is S. H. McCrory, chief, USDA Bureau of Agricultural Engineering. Supporting the boulder is B. B. Robb, professor of agricultural engineering, Cornell University, to whom belongs the lion's share of credit for the achievement which this memorial represents. Center, secretary of ASAE

in some fitting manner the occasion of the one hundredth anniversary of his work. The active interest of these two men over a period of several years, and especially the untiring personal efforts of Mr. Robb during the past year or two, finally culminated in the actual achievement of this beautiful memorial to John Johnston and his outstanding engineering contribution in the application of tile to underdrainage of the soil.

Preceding this event, the North Atlantic Section of the Society held a most interesting and worth while meeting in Willard Straight Hall on the Cornell University campus.

The first day's program included papers on soil erosion control in the northeast area, recent improvements in farm machinery, the better use of farm land, experimental results on farm milk coolers with ice, and the use of electricity on farms. During the evening of the same day two interesting round table sessions on rural electrification and farm machinery were held.

The forenoon session of the second day was featured by interesting papers on brooding chicks and game birds, on the Tompkin County Development Association, on writing bulletins, and on research in agricultural engineering at the agricultural experiment stations.

At the opening of the afternoon session, the group listened with great interest to Dr. G. F. Warren, professor of agricultural economics and farm management at Cornell, discuss the monetary situation from a national and international viewpoint. During the middle of the afternoon the group left Willard Straight Hall for a trip of about twenty miles through the area near Ithaca in which the damage from the flood of last July was most serious. This trip ended at Taughaunock Farm near Ithaca for an old-fashioned country dinner, and a most enjoyable occasion. R. W. Trullinger of the USDA Office of Experiment Stations officiated as toastmaster. The group was addressed by L. F. Livingston, president of the American Society of Agricultural Engineers, whose address appears elsewhere in this issue. He was followed by E. R. Eastman, editor of "American Agriculturist," whose talk on agriculture and the part which agricultural engineers play therein was listened to with a great deal of interest. Following the dinner session, the group divided into three round tables on rural electrification, farm structures, and college teaching.

The forenoon session of the third day was featured by a paper on low-cost wiring on the farm, which appears elsewhere in this issue, and by an interesting paper on the preservation of leguminous forage crops for silage purposes.

At a business session held during the meeting, Geo. A. Rietz, in charge of rural electrification for the General Electric Company, was elected chairman of the Section for the coming year; he has served several years as secretary-treasurer of the Section. W. C. Krueger, extension agricultural engineer, New Jersey State College of Agriculture, was elected vice-chairman, and Frank H. Hamlin, Papec Machine Company, secretary-treasurer.

Washington News Letter

THE AMERICAN Engineering Council's grist of engineering news from Washington, under date of October 15, contains the following interesting items:

The approval of projects under the federal work relief program has been speeded up in recent weeks to make work available against the winter peak in operations. The jurisdiction of federal agencies over portions of the program has been clarified and funds have been shifted, especially to WPA whose position is strengthened as a means of providing quick jobs.

Discontinuance of the Division of Applications and Information, and clarification of functions of the Advisory Committee on Allotments, seem to place broad discretionary power under the state administrators and directors as to the carrying out of approved projects and the advancement of projects not yet approved.

Engineers interested in individual projects should be reminded that the President insists upon the certification of each project by the comptroller general and conditions his approval upon that certification. It is further noted that numerous projects have been rescinded after their conditional approval.

Employment under the program on or about November 1 will be close to the approximate goal of 3,500,000 set for that date, in the belief of federal officials. As of early October, CCC was approaching a complement of 600,000; WPA was employing about 500,000; and some hundreds of thousands were on state ERA projects not yet transfered to WPA, in addition to work being furnished by PWA and other federal agencies entering the program.

The Works Progress Administration, the largest spending and employing agency of the program, has been given a high degree of flexibility through the approval of approximately twice as many projects as there is money to finance. In other words, each state has a pool of projects from which to draw in placing the jobless in work suited to their individual skills, with latitude as to the selection of projects at the time and place most needed. State administrators have been told that they must, in so far as possible, give work to all eligibles, must finish projects or project units once begun, and must plan purchases of materials so as to avoid either a shortage or a surplus. The expectation is that WPA will handle work aggregating more than $1,000,000,000.

Of primary importance is the entrance of the Corps of Engineers of the Army into the WPA program. Lt. Col. F. C. Harrington has been appointed chief engineer of WPA. Officers of the Corps have been appointed consulting field engineers in eleven areas of the United States. The consulting field engineers soon will visit their areas to secure full information as to the works program in each state, with "particular regard to those obstacles or difficulties which are hampering the speedy development of the program."

Specialized WPA phases of engineering significance include water conservation and irrigation projects now authorized for state WPA programs. Airports under WPA are subject to the approval and technical supervision of state representatives of the U. S. Bureau of Air Commerce. Planning, statistical, and research projects may be sponsored by state planning boards, aided by the state planning consultants of the national resources committee. Area statistical officers are being established to serve as clearing houses for reports on the work of all federal agencies entering the work relief program in the respective areas.

The Public Works Administration is going forward with a new program involving between 3,000 and 4,000 projects in which federal grant from new money and loans from the PWA revolving fund amount to about $500,000,000. With the addition of funds which the project sponsors have secured by private borrowings, the program amounts to about $750,000,000 of new construction. In addition, numerous projects are in various stages of construction under the old PWA program.

Project sponsors have been warned that they must have contracts let and must be ready to start work on their PWA projects by the December 15 deadline set by the President. Otherwise their projects are likely to be rescinded and the funds transferred to other worthy jobs for which PWA has applications on file.

Authority has been granted to exempt PWA projects from the requirement that 90 per cent of the labor be taken from relief rolls. Where insufficient relief labor of the necessary skill is available in the vicinity of a project, suitable workers may be selected through the U. S. Employment Service, with preference to bona fide residents of the political subdivision helping to finance the work. Provision may be made for supplying contractors with union labor with first preference to regular employes of the contractor who are on relief and with further preference to other union members who are on relief. A previous order also modified the relief labor requirement for employes of the PWA slum clearance program.

PWA wage rates have been clarified so that projects under the old and the new PWA program are placed on the same basis. The "prevailing wage principle" is to be followed. The project applicant shall determine the wage rates "in accordance with local wage conditions" subject to the approval of the PWA state director. WPA wage schedules have been set on a population basis.

PWA's new director of engineering is Capt. Jabez B. Gholston. He succeeds Clarence McDonough who resigned to become general manager of the Lower Colorado River (Texas) Authority.

Indefinite continuation of the Civilian Conservation Corps is contemplated in plans which call for a tapering off of enrollment from a peak of about 600,000 to 300,000 next July. Of approximately 750,000 young men who finish their formal education each year, some 600,000 are employable. On the basis discussed, the Corps could offer half of these a year of out-of-door work at some time in their young manhood. The age limit for enrollment, originally 18 to 25, has been widened from 17 to 28. WPA also plans to employ young men and women from 16 to 25, especially those from large relief families, to supplement the primary earnings of heads of families carried under the work program.

Developments under WPA, PWA, and CCC have tended to overshadow the work of many other federal agencies whose part in the program is of continued interest to engineers. Further announcements from these agencies should be watched for in the next few weeks.

"The Engineer's Duty as a Citizen," a pamphlet prepared as an outline for a discussion course at the Newark College of Engineering, is now in its third edition.

The author, Roy V. Wright, editor of the "Railway Age" and other trade publications, has made revisions during the summer. New material added includes an account of the political experiences of Joshua D'Esposito, builder of Chicago's $100,000,000 Union Station, who ran for office on a reform ticket. The work of Col. William J. Wilgus, railroad engineer and executive, who came out of retirement to direct work relief in New York City, also is described. The pamphlet seeks to outline, with specific examples, some of the ways in which engineers can discharge their civic responsibilities as individuals, or by group action. Copies are obtainable at 25 cents each from the book store of the Newark College of Engineering, 367 High Street, Newark, N. J.

The annual meeting of American Engineering Council will be held in Washington, January 9, 10, and 11. To draft the general outlines of the program for the annual meeting, to get the sense of direction as to topics for consideration and action, and in general to restate the purposes and conclusions of the standing committees of Council, the Public Affairs Committee and the Executive Committee of Council will hold meetings in Washington on November 1 and 2.

Plans for securing the considered opinion of the enlarged membership of AEC at the annual meeting will be perfected in the November sessions, with special reference to the representation of new state and local engineering societies of which some 15 have been elected to membership in Council since the last annual meeting. Council at the present time, through its member organizations, represents 38 engineering bodies composed of 7 national societies and 31 state and local engineering organizations.

New members of Council, since the new membership plan of nominal dues to state and local societies went into effect in January, 1935, include the following:

State societies: Arkansas Engineers Club, Little Rock; Engineering Societies of New England, Boston; Florida Engineering Society, Gainesville; Louisiana Engineering Society, New Orleans; Maryland Association of Engineers; Michigan Engineering Society, Detroit; and South Carolina Society of Engineers, Columbia.

Local societies: Associated Engineers of Spokane, Wash.; Cleveland Engineering Society, Ohio; Engineers Club of Baltimore, Md.; Engineers Club of Columbus, Ohio; Engineers Club of Philadelphia, Pa.; Engineers Club of St. Louis, Mo.; Engineers Society of Western Pennsylvania, Pittsburgh, Pa.; and Providence Engineering Society, R. I.

Pacific Coast Section Meeting

THE next meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, which will be the fourteenth yearly meeting of that Section, will be held at Davis, California, on January 10 and 11. Aside from the regular business session, including preliminary reports of committees working on plans for the 1938 annual meeting of the Society which will be held in California, the meeting will be devoted to more or less formal papers dealing with a variety of subjects. The Society president, L. F. Livingston, has accepted the invitation of the Section to be present at the meeting, and he will deliver an address at the dinner on the evening of January 10.

The regular technical program will include two papers on structures, one on "Adobe Buildings" by J. D. Long, and another on "Small Farm Structures" by Max E. Cook. Two papers on dehydration will include one on "The Mechanical Requirements for Walnut Dehydration," by Ben D. Moses, and one on "Dehydration of Citrus Fruits" by W. P. Duruz. The subject of soil conservation will be featured by two papers, one by J. G. Bamesberger, chief engineer of the USDA Soil Conservation Service in the California area, and one by W. A. Rockie, SCS regional director in the Pacific northwest. S. W. McBriney will contribute a paper on "The Mechanical Topping of Beets," Vernon Givan will present one on "Irrigation Studies in the Santa Clara Valley," and a paper on "Rapid Haymaking Equipment" will be presented by George Glendenning. Three rather general papers will include one on "The Architecture for Resettlement Projects," by John Weston, another on "Rural Electric Service Department of Power Companies," by Emil J. Smith, and "Impressions of TVA" by H. B. Walker.

Further information relative to the meeting may be secured from the secretary of the Pacific Coast Section, Walter W. Weir, 320 Hilgard Hall, Berkeley, Calif.

Personals

F. D. Cornell, Jr., assistant professor of farm mechanics, West Virginia University, is author of Bulletin 267, entitled "Power on West Virginia Farms," recently issued by that institution.

J. B. Davidson, E. V. Collins, and *E. G. McKibben,* members of the agricultural engineering staff, Iowa State College, are joint authors of Research Bulletin No. 189, recently issued by that institution, and entitled "Tractive Efficiency of the Farm Tractor."

Donald Christy has been appointed an associate professor of agricultural engineering at the A. & M. College of Texas, College Station. He was previously an agricultural engineer in the USDA Soil Conservation Service.

E. E. Einfeldt, formerly chief engineer of French & Hecht, is now holding the same position with Havana Metal Wheel Co.

R. E. Everitt recently joined the engineering staff of the John Deere Tractor Co., Waterloo, Iowa. Previous to that he was employed as agricultural engineer in one of the CCC camps in Illinois.

W. F. Heesch was recently made general manager of the Havana Metal Wheel Co. He was formerly in a similar capacity with French & Hecht.

W. D. Hemker formerly rural engineer, Wisconsin Power and Light Company, is now connected with Westinghouse at Pittsburgh in a similar capacity.

J. L. McKitrick was appointed a few months ago as one of the state extension agricultural engineers, University of Kentucky.

G. E. Martin resigned as agricultural engineering extension specialist for the state of Missouri to accept, on October 1, a similar position with the agricultural extension service of the University of Tennessee, Knoxville.

Lee W. Minium, more recently on the agricultural engineering staff of South Dakota State College, is now connected with the U. S. Soil Conservation Service and is located at Huron, South Dakota.

Bernard H. Osterloh, formerly on the agricultural engineering staff at the University of Nebraska, is now supervising engineer (ECW), USDA Soil Erosion Service, at Albion, Nebr.

J. D. Parsons is an agricultural engineer in the USDA Soil Erosion Service at Zanesville, Ohio—formerly in the Forest Service.

V. S. Peterson is ECW State administrator for Indiana. He was formerly an agricultural extension engineer in Iowa, and later chief technician and acting director of 15 (Iowa) ECW camps.

Geo. O. Sanford was recently advanced from chief of the engineering division to supervisor of operation and maintenance in the Bureau of Reclamation, U. S. Department of the Interior.

Dan Scoates, head of the agricultural engineering department, A. & M. College of Texas, is temporarily regional chief, Resettlement Administration, with headquarters at Stillwater, Okla.

H. N. Stapleton recently resigned as instructor in agricultural engineering, Pennsylvania State College, to accept appointment as state extension agricultural engineer for Vermont. His new address is University of Vermont, Burlington.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the October issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Roy H. Bredal, agricultural engineering draftsman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Old Post Office Bldg., Meridian, Miss.

Paul A. Calhoun, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 67, West Point, Miss.

James E. Hale, manager, development department, Firestone Tire and Rubber Co., Akron, Ohio.

Carl A. Johnson, sales manager, implement and industrial division, Motor Wheel Corporation, Lansing, Mich.

Chris Nyberg, assistant chief engineer, Oliver Farm Equipment Co., Battle Creek, Mich. (Mail) 4 Pioneer Ave.

Howard T. Palmer, senior technical foreman, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Hebron, Nebr.

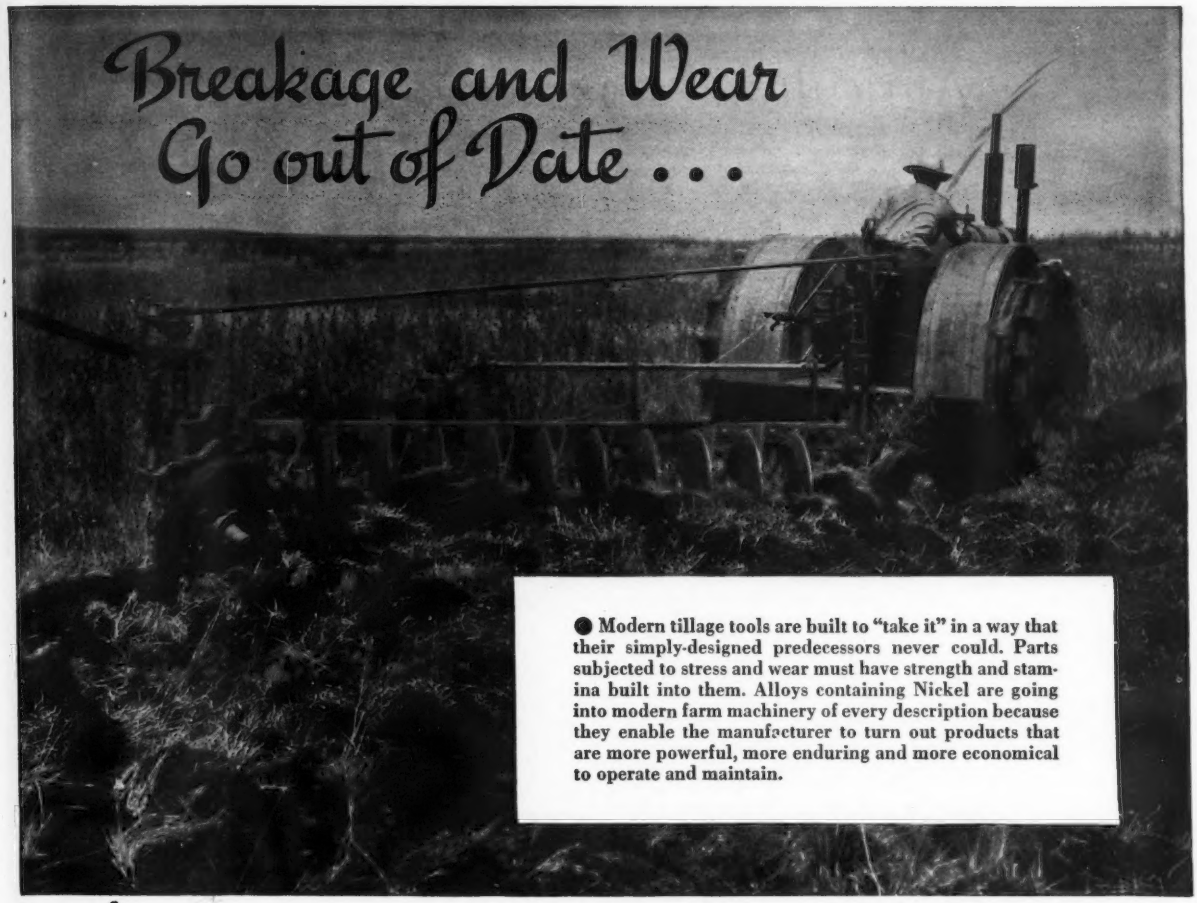
A. E. R. Peterka, metallurgical engineer, The Lamson & Sessions Co., Cleveland, Ohio. (Mail) 3150 West 82nd St.

E. S. Walker, manager, Banes Division, United Fruit Co., Banes, Oriente, Cuba.

Forrest B. Wright, assistant professor of agricultural engineering, N. Y. State College of Agriculture, Cornell University, Ithaca, N. Y.

TRANSFER OF GRADE

Frank H. Hamlin, director, Papec Machine Co., Shortsville, N. Y. (Affiliate)



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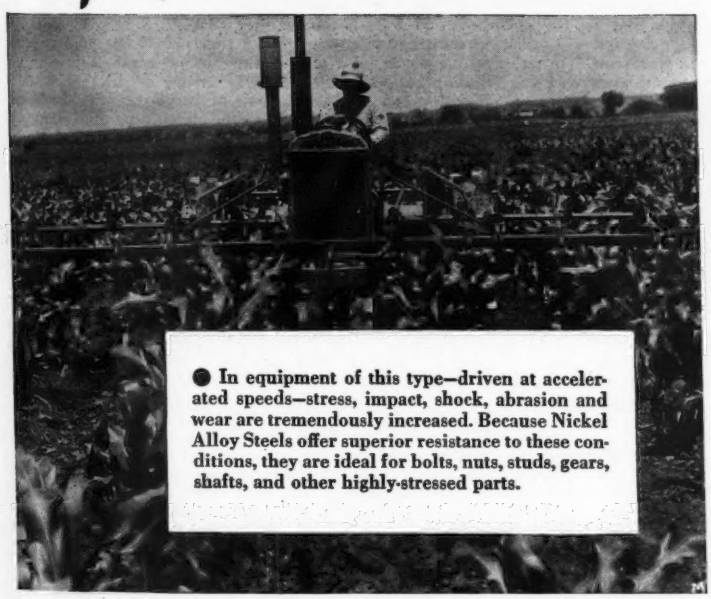

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Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

BEHAVIOR OF CASEIN AND BLOOD GLUE JOINTS UNDER DIFFERENT CONDITIONS OF EXPOSURE, *D. Brouse.* U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1934, pp. [1] + 8, pl. 1; also in Furniture Manfr., 48 (1934), no. 3, pp. 9-11, fig. 1; Wood Prod., 12 (1934), no. 10, pp. 8-10, fig. 1. Studies are reported in which well-made plywood specimens of approximately equal strength were exposed to (1) continuous soaking in water, (2) 97 per cent relative humidity at a temperature of 80 deg F, (3) alternate soaking and drying under high mechanical stresses, and (4) alternate high and low relative humidity. A total of 270 specimens for each of three different glues were tested.

The durability of the joints under continued soaking was surprisingly high. After 3 years the joints made with blood glue retained 67 per cent of their original dry strength, or about 81 per cent of the original wet strength. Joints made with the low alkaline casein glue remained in test for 28 months before total failure, while the joints made with the casein glue of higher alkalinity failed in 15 months.

The results support the view that chemical hydrolysis of the protein is the most important factor in the destruction of water-resistant protein glue joints under continuous soaking. The casein glue of high alkalinity failed most rapidly, the casein glue of low alkalinity failed more slowly, and the joints made with the paraformaldehyde blood glue (hot-pressed) were still intact after 36 months. Presumably, adding paraformaldehyde as a part of the blood glue formula together with hot pressing alters the nature of the protein in blood in such a way that it hydrolyzes very much more slowly than the protein present in a casein glue. Mechanical stresses on the glue joint caused by alternate swelling and shrinking of wood could scarcely have been a factor in this group of tests.

The results of continuous exposure to 97 per cent relative humidity strongly supported the view that untreated glue joints fail under this type of exposure mainly because of attack by microorganisms. The joints made with the casein glue of low alkalinity failed just as rapidly as joints made with the highly alkaline casein glue and both failed more rapidly than did the joints made with either glue and soaked continuously.

In the repeating cycle of 2 days soaking followed by 12 days at 30 per cent relative humidity, all specimens, even those glued with the highly water-resistant blood glue, failed completely by the end of 25 months. Specimens glued with casein glue failed by the end of 13 months. Mechanical stresses appeared to be the main cause of failure in this group of tests. The drying period is believed to be particularly damaging to the joints. The plies dry and begin to shrink while the glue is still in the swollen and weakened state from the soaking; the result is an early opening of the glue joint, the failure appearing first at the edges of the specimens. The repeating cycle of 2 weeks at 97 per cent relative humidity followed by 2 weeks at 30 per cent relative humidity provided conditions favorable to mechanical stresses and moderately favorable to mold action. Mold action was a factor, for the specimens gave clear evidence of the development of molds and other fungi. Mechanical stresses must be considered of major importance for the plywood changes in moisture content from roughly 25 per cent at 97 per cent relative humidity to about 7 per cent at 30 per cent relative humidity. For this type of exposure it appears important to have a glue that first of all withstands mechanical stresses and, secondly, resists mold attack.

BRIDGE PIERS AS CHANNEL OBSTRUCTIONS, *D. L. Yarnell.* U. S. Dept. Agr. Tech. Bul. 442 (1934), pp. 52, pls. 8, figs. 24. This bulletin presents the results of about 2,600 experiments on the obstructive effect of bridge piers to flow of water, using larger piers and a more extensive range of conditions than has hitherto been attempted. The tests were conducted by the U. S. Bureau of Agricultural Engineering and the University of Iowa during 1927 to 1931.

It is pointed out that the bridge pier formulas most commonly used in the United States are D'Aubuisson's, Nagler's, Weisbach's, and Rehbock's. The discordant results obtained with the Weisbach formula show it to be theoretically unsound.

None of the above formulas give for a certain shape of pier a constant coefficient for all channel contractions. This factor is of vital importance and is the reason for the inconsistent results obtained in the past by engineers attempting to solve problems involving backwater from bridge piers. The majority of such problems concern cases having channel contractions of less than 20 per cent.

As long as the velocities are low enough to keep within what Rehbock calls Class 1 flow, any one of the three formulas will give results close enough for practical purposes, if the proper coefficient is used. This coefficient varies with the channel contraction as well as the pier shape. Proper values for channel contractions of less than 11.7 per cent were not determined, and for most of the pier shapes they also are not determined for contractions greater than 23.3 per cent. However, most backwater problems fall within this range, but as the D'Aubuisson and Rehbock formulas give quite different coefficients at 11.7 per cent than they do at 23.3 per cent, and as no points are known between them, the shape of the curve remains undetermined. This objection does not apply to the Nagler formula because there is little difference in the coefficients for 11.7 per cent and 23.3 per cent, and the tests of the square and semicircular shapes indicate that a constant average value can be used throughout the range. The Nagler formula also applies through Rehbock's Class 2 and into the beginning of Class 3. The other two formulas do not apply at these higher velocities (except with continually varying coefficients), and thus fail in the most serious cases of "heading-up" due to extreme floods.

The conclusion is drawn that the height of the backwater due to bridge piers varies directly as the depth of the unobstructed channel. Certain formulas heretofore proposed give approximately correct results for ordinary velocities when the proper coefficients are used, but they do not hold for extremely high velocities. For the lower velocities (Class 1 flow) the more efficient shapes are lens-shaped nose and tail, lens-shaped nose and semicircular tail, semicircular nose and lens-shaped tail, convex nose and tail, and semicircular nose and tail.

Twin-cylinder piers either with or without connecting diaphragms, piers with 90-degree triangular noses and tails, and piers with recessed webs are less efficient hydraulically than those just mentioned, and piers with square noses and tails are least efficient. The addition of batter to the ends of piers slightly increases their hydraulic efficiency. Increasing the length of a pier from 4 times the width to 13 times the width has comparatively little effect on its hydraulic efficiency. In some cases it increases it and in some cases decreases it. The optimum ratio of pier length to width probably varies with the velocity and is generally between 4 and 7.

Placing the piers at an angle with the current has an insignificant effect on the amount of backwater if the angle is less than 10 deg. Placing the piers at an angle of 20 deg or more with the current materially increases the amount of backwater, the increase depending upon the quantity of flow, the depth, and the channel contractions.

A large amount of reference material is included, together with an appendix relating to the energy method of computing heading-up due to piers.

POWER FOR THE GRINDSTONE, *H. N. Colby* and *W. T. Ackerman.* New Hampshire Sta. Circ. 43 (1935), pp. 6, figs. 4. The results of a study are reported which indicate that ⅓ hp is ample to drive a grindstone for the average farm sharpening operations. The speed should not exceed 60 rpm unless the stone is kept perfectly true. A speed of 48 to 50 rpm proves more satisfactory for the average grindstone which is not perfectly round. The belt and direct gear driven units are more satisfactory than the combination gear-and-chain unit. The stone should be not less than 2.5 in in thickness, and should be discarded when worn to 12 in in diameter, as a smaller stone does not do the work as fast as a larger one nor does it allow necessary freedom of motion. For efficient work, the stone should be between 22 and 30 in in diameter, preferably nearer 30 in, and should be trimmed occasionally to maintain a smooth, true working surface. For most economical operation, the grindstone should not run in a trough containing water, as the constant soaking will cause rapid wear. Water should be allowed to run on the stone from a spout leading from a substantial container mounted at one end of the grindstone frame, the flow being controlled by a drain cock on the spout.

Detailed plans are included for the construction of the gear-driven stone found most efficient. *(Continued on page 462)*

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Agricultural Engineering Digest

(Continued from page 458)

THE GAME OF PLANNING A HOUSE, *D. Scoates*. Dallas, Tex. Southwest Press, 1933, pp. VII + 150, figs. 53. This is a popular treatise on house planning prepared primarily to assist the layman in assembling his ideas relative to the house he wishes to construct. It is based on many years' experience in research and teaching in the land-grant colleges of Texas, Mississippi, and other states. It contains chapters on size of rooms, standard sizes of rooms, arrangement of rooms, sizes of houses, finishing the best solution, visualizing the complete plan, what about the outside, and remodeling, and a bibliography.

NEBRASKA TRACTOR TESTS, 1920-1934. Nebraska Sta. Bul. 292 (1935), pp. 40. This bulletin summarizes the results of 81 of the 221 tractor tests conducted during the past 15 yr, and includes data on all tractors reported by their manufacturers as on the market January 1, 1935.

General procedure used and rules followed in testing tractors are outlined, and the text of the farm tractor rating code of the American Society of Agricultural Engineers and the Society of Automotive Engineers is presented, together with the text of the Nebraska tractor testing law.

INVESTIGATIONS ON DISK HARROWS [trans title], *O. Freiberg*. Technik Landw., 15 (1934), no. 9, pp. 200-203, figs. 5. The results of studies of tractor-drawn disk harrows with working widths of from 2.15 to 2.80 m (7.05 to 9.18 ft), number of disks from 28 to 36, and disk diameter of 16 in are reported. The results were related to the dynamic properties of the test soils.

The increasing draft with increasing angle of inclination of the disks was attributed to the increased specific pressure of the soil per unit area of disk. With the disks tested the optimum angle of inclination was 17 deg. This angle was found to be determined by radius of curvature and the diameter of the disk. The draft increased with the weight and loading of the disk harrow. This is attached primarily to the physical composition of the soil since the draft increased with an increase in the proportion of fine particles in the soil and with higher moisture content.

The draft of disks of larger diameter was smaller than that of disks of smaller diameter but having the same radius of curvature, although the working width of the disks increases with their diameter. The draft increased around 5 per cent for every 1 per cent increase in soil moisture content.

The weight of the disk harrow was found to be an important factor in the efficiency of its performance. Large disks with large curvature performed less efficiently than small disks with smaller curvature.

It was found that rapid, more shallow disking gave better tillage results than slow, deeper disking.

REMODELING THE SQUARE HOUSE, *J. C. Wooley* and *F. Clark*. Mo. Agr. Col. Ext. Circ. 320 (1935), pp. 4, figs. 4. Practical information and working drawings are presented for remodeling the square house.

EROSION CONTROL AND THE CULTIVATION OF HILLSIDES [trans. title], *A. Piedallu*. Jour. Agr. Prat., 99 (1935), no. 6, pp. 128-131, figs. 5. Technical information and drawings are presented relating to French practice in the terracing of steep hillside lands and the conservation of runoff water between terraces. The practices include rather heavy levee construction of both soil and masonry and blasting the subsoil of the terrace ditches to increase moisture absorption.

COMPACT DATA FOR CHECKING OIL BURNER COMBUSTION, *F. G. Sefing*. Heating and Ventilating, 32 (1935), no. 3, pp. 17, 18, fig. 1. Graphic data are presented which permit the checking of oil burner combustion using only a thermometer and a carbon dioxide analyzer.

ELECTRIC BROODERS. Rural Electrif. and Electro-Farming, 10 (1934), no. 115, pp. 222-224, figs. 4. Practical information is given on the subject from English sources.

AGRICULTURAL EXPLOSIVES [trans. title], *C. Houdayer*. Jour. Agr. Prat., 99 (1935), no. 2, pp. 38-42, figs. 7. Technical information is presented relating to French practice in the use of explosives for preparing holes for the planting of fruit trees.

ELECTRIC HEAT IN GARDENING [trans. title], *Kind* and *Reinau*. Reichskurator. Techn. Landw. Schr., no. 52 (1934), pp. 91, figs. 26. This is a technical treatise on the use of electricity in greenhouses, hotbeds, and the like, the data being drawn from various studies and instances of practical experience in Germany.

Considerable space is devoted to the heat requirements of greenhouses, forcing beds and hotbeds, and the manner in which electricity can be adapted for this purpose. A large amount of electrotechnical information is included on electrical equipment for various purposes and its correct use.

FRUIT TREE SPRAYING EQUIPMENT, *J. Turnbull*. Sci. Hort. [Wye. Kent. Eng.], 3 (1935), pp. 24-32. Fruit tree spraying equipment used in England is described.

IRRIGATION OF VEGETABLE CROPS, *F. A. Secrett*. Sci. Hort. [Wye. Kent. Eng.], 3 (1935), pp. 82-96, figs. 5. Practical information is given on the subject, with particular reference to the requirements of English conditions.

MACHINERY IN VEGETABLE PRODUCTION, *S. J. Wright*. Sci. Hort. [Wye. Kent. Eng.], 3 (1935), pp. 97-108, figs. 12. Machines used in vegetable production in England are described.

SOIL EROSION AND ITS PREVENTION, compiled by *D. Graf*. U. S. Dept. Agr., Bur. Agr. Engin., 1935, rev., pp. 91. This is a partial mimeographed list of references on the subject.

GASOLINE AND MOTOR OIL INSPECTION. Maine Sta. Bul. 377 (1934), p. 413. Data are presented from analyses of 164 samples of gasoline and 139 samples of motor oil.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE ARIZONA STATION. Arizona Sta. Rpt. 1934, pp. 22, 23, 24-27. The progress results are briefly presented of investigations on fluorine in drinking water, rural housing, ground water, and pumping machinery.

BIBLIOGRAPHY ON FOOD CONTROL, compiled by *D. Graf*. U. S. Dept. Agr., Bur. Agr. Engin., 1935, pp. 9. This mimeographed bibliography contains over 100 references to literature on the subject.

DRAINAGE AND IRRIGATION, SOIL, ECONOMIC, AND SOCIAL CONDITIONS, DELTA AREA, UTAH.—DIV. 1, DRAINAGE AND IRRIGATION CONDITIONS, *O. W. Israelsen*. Utah Sta. Bul. 255 (1935), pp. 70, figs. 8. It is the purpose of this bulletin to present the results of parts of a detailed cooperative study of some of the factors which have contributed to the financial difficulties on certain projects on the Delta area in Utah. A large amount of data is projects and conclusions mainly of local significance are drawn.

SOIL EROSION IN MISSOURI, *L. D. Baver*. Missouri Sta. Bul. 349 (1935), pp. 66, figs. 23. It is the purpose of this report to (1) present the picture of the seriousness of erosion in the state as it now exists, (2) call attention to the factors that have contributed to soil losses by erosion, and (3) suggest possible means of controlling erosion most effectively throughout the various sections of the state in accordance with the properties of the soils.

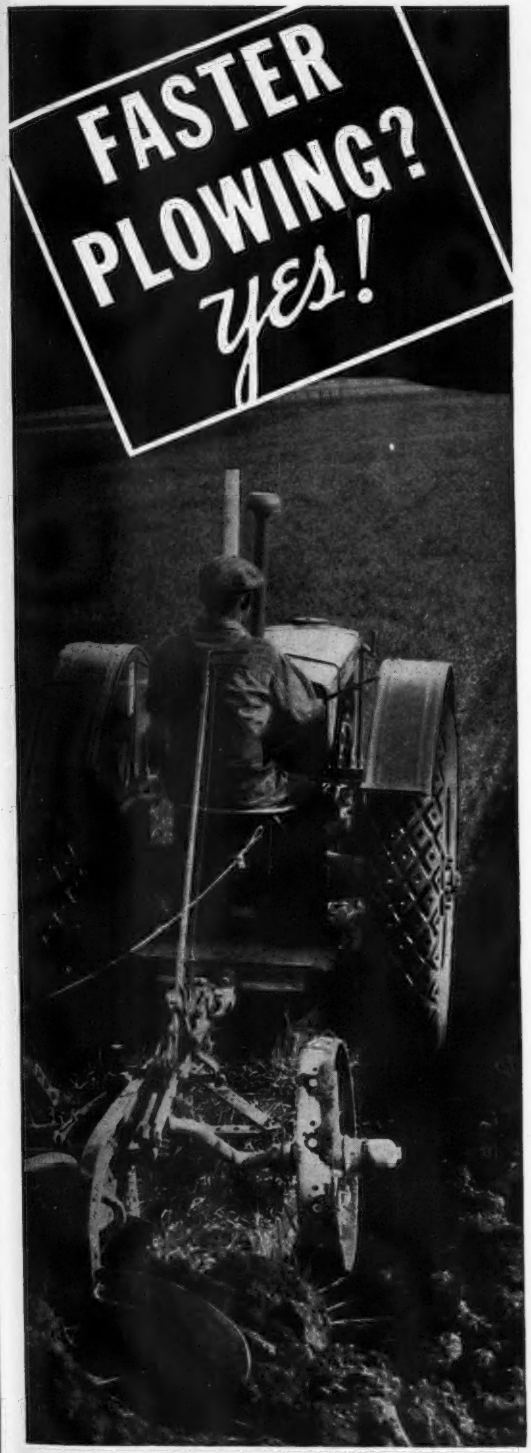
CONSTRUCTION OF IRRIGATION WELLS IN COLORADO, *W. E. Code*. Colorado Sta. Bul. 415 (1935), pp. 43, figs. 26. A large amount of technical information is presented relating to large excavated wells, metal well casings, tools and methods used in sinking metal-cased wells, development of metal-cased wells, test hole drilling, design of metal-cased wells, well characteristics, and well contracts and cost of wells.

In an endeavor to obtain information on the effects of diameter on discharge, several experiments were made at different places. In each case, wells of more than one size were involved, and in order to correlate results, many gravel samples were taken. Mechanical analyses were made of all the samples, and each was subjected to a percolation test.

The results of some of these experiments are presented.

ARTIFICIAL CURING OF FORAGE CROPS, *H. T. Barr*. Louisiana Sta. Bul. 261 (1935), pp. 14, figs. 4. The results of 5 yr of investigations on artificial curing of hay are summarized. These indicate that artificial drying of hay crops is an economical and practical operation in the humid area.

By artificial curing, a hay may be produced which is uniform as to color, odor, and food value, regardless of weather conditions. Feeding trials with beef cattle gave faster gains on machine-dried soybean hay as compared to chopped field-cured soybean hay. Feeding trials have shown 2,000 lb of artificially cured hay to be equivalent to 3,237 lb of long field-cured soybean hay for beef cattle. Dairy cattle gave favorable results on artificially cured hays for each of the 3 years' tests.



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